

Water Quality Assessment for Migrating Fish

Frank A.P.C. Gobas and Justin C. Lo

School of Resource & Environmental Management

Simon Fraser University

Burnaby, BC, Canada

Executive summary:

This brief summary report documents the development and application of a bioaccumulation model for fish to propose water quality guidelines for the protection of human consumers of migrating salmon species in the Columbia River system. The model, developed as an Excel spreadsheet, is attached and proposed water guidelines for 94 chemicals are calculated. The calculated water quality guidelines are compared to existing water quality guidelines developed by the US Environmental Protection Agency (EPA) to identify if guidelines need to be considered for revision or updating.

Introduction:

Risk-based concentrations (RBCs) for water in the Columbia River were estimated based on the consumption of migrating fish and drinking contaminated water (when data available). The RBCs were calculated based on (1) available reference dose (RfD) values protective for non-carcinogenic (threshold based) toxicity and (2) available cancer slope factor (CSF) values protective for carcinogenic (non-threshold-based) toxicity for 94 chemicals. The RBCs are then compared with available human health water quality guidelines (HH WQGs) from the EPA and Idaho databases to evaluate whether current environmental quality criteria are sufficiently protective for human consumers of fish.

Methodology:

A bioaccumulation model, parameterized for migrating salmon in the Columbia River, was applied to estimate the dietary exposure component of the water RBCs. The model was based on a recently published bioaccumulation model developed by the authors to investigate biotransformation rates of chemicals in fish (Lo et al. 2015).

Model Application to migrating salmon

Figure 1 shows the bioaccumulation model adjusted to specific environmental conditions for the migrating salmon. Since there is no food ingestion for the migrating fish, the dietary uptake and fecal egestion parameters do not play a role in the model. Although most application of the bioaccumulation model consider the change in body mass over time ($dW_s/W_s dt$) as an elimination pathway for chemicals in fish ('growth dilution'), the change in body mass over time is negative and therefore cause a magnification of the concentration of the chemicals in migrating fish. The depletion of lipids over time ($dE_s/E_s dt$) for migrating fish causes an additional magnification of the concentration of hydrophobic chemicals in fish (DeBruyn et al. 2004). This bioaccumulation model for migrating fish was

parameterized to specific exposure times and various body compositions of specific salmon populations in the Columbia River system.

Chinook and Sockeye (Male and Female) Salmon were evaluated in different migration routes (Table 1). Because the salmon are migrating, it is not expected that the fish are in steady state with the river water levels. As a result, temporal Bioconcentration Factors (BCFs) were calculated based on the specific exposure times. Exposure times were estimated based on the travel distance and mean swimming speed. Body composition data from Brett 1999 v⁶ used to estimate change in body mass over time ($dW_s/W_s dt$) and the depletion of lipids over time ($dE_s/E_s dt$) for the Chinook and Sockeye (male and female) Salmon in this study. Body composition data are summarized in Table 2.

Fish and migration pathway-specific temporal BCF values were calculated in order to estimate water Risk Based Concentrations (RBCs) that could present a risk to humans through cancer based and non-cancer based risk models. Temporal BCF values with metabolism (k_{BM} estimates from EPI SUITE v 4.11) and without metabolism ($k_{BM} = 0$) are given in Table A1 of the Appendix section. Somatic biotransformation rate constant (k_{BM}) estimates from EPI SUITE v 4.11 were normalized to the fish weight in the study.

Chemicals

Chemicals evaluated in this study and their CAS numbers, log K_{ow} values, empirical bioconcentration factors (BCF_{exp}), cancer slope factors (CSF), and reference dose (RfD) are given in Table 3. Recommended log K_{ow} values from the EPI SUITE v. 4.11 program were used. Chemical concentrations for drinking water⁷ not currently available and assumed to be zero, but can be defined⁸ by the user in the 'Drinking Water' tab of attached excel spreadsheet.

Model Performance Evaluation

The model was assessed for its accuracy by comparing Bioconcentration Factors (BCFs), derived by the model, to empirical BCF values from the EPI SUITE v. 4.11 database (US EPA 2012), normalized to 10 g size fish with 5% lipid content. We refer to further details on the parameterization of fish and environmental characteristics in the 'Model Assessment' Tab of the attached Excel Spreadsheet. There is a reasonable agreement with empirical BCF values when the model assuming no somatic biotransformation (Figure 2, top) of the chemicals by the fish, and a better agreement when including somatic biotransformation rate constant estimates (Figure 2, bottom). Somatic biotransformation rate constants were estimated using the BCFBAF QSAR implemented in the EPI SUITE v. 4.11 program.

Risk Models

Fish and migration pathway-specific temporal BCF values were calculated in order to estimate water Risk Based Concentrations (RBCs) that could present a risk to humans through cancer based and non-cancer based risk models. A fish consumption rate of 0.175 kg/d, water consumption rate of 2.5 L/d, and bodyweight⁹ of 80 kg was used for the risk models. RBCs were calculated based on an Acceptable Risk level of 1.0×10^{-6} in cancer based risk assessments, and a Hazard Index of 1 for non-cancer based assessments (Table 4).

Cancer based risk

A non-threshold cancer based risk model using Cancer Slope Factors (CSFs), when available, was applied to calculate water RBCs for each chemical, following an overall acceptable risk level (R_{total}) of 1.10^{-6} :

$$R_{total} = CSF \cdot dose_{total} \quad (1)$$

$$\begin{aligned} &= CSF \cdot ((CR_{fish} \cdot C_{F,cancer} / BW) + (CR_{water} \cdot C_{W,drinking} / BW)) \\ &= CSF \cdot ((CR_{fish} \cdot C_{W,cancer} \cdot BCF / BW) + (CR_{water} \cdot C_{W,drinking} / BW)) \\ &= (CSF / BW) \cdot (C_{W,cancer} \cdot CR_{fish} \cdot BCF + CR_{water} \cdot C_{W,drinking}) \end{aligned}$$

Where $C_{F,cancer}$ is the RBC in the fish, BCF is the temporal bioconcentration factor adjusted to the fish and migration pathway, $C_{W,drinking}$ is the chemical concentration in the drinking water, and $C_{W,cancer}$ is the river water RBC. From Equation 1, the RBC can be rewritten as:



$$C_{W,cancer} = ((R_{total} \cdot BW / CSF) - CR_{water} \cdot C_{W,drinking}) / (CR_{fish} \cdot BCF) \quad (2)$$

Note that a high enough $C_{W,drinking}$ could present a risk from drinking that is larger than the defined overall risk level. Risk based Concentrations calculated on for cancer risk are given in Table A2 of the Appendix section.

Non-cancer based risk

A threshold non-cancer based risk model using Reference Dose (RfD) values, when available, was applied to calculate water RBCs for each chemical, following a Hazard Index of 1 ($HI = dose_{total} / RfD$). Therefore:

$$RfD = dose_{total} \quad (3)$$

$$\begin{aligned} &= (CR_{fish} \cdot C_{F,non-cancer} / BW) + (CR_{water} \cdot C_{W,drinking} / BW) \\ &= (CR_{fish} \cdot C_{W,non-cancer} \cdot BCF / BW) + (CR_{water} \cdot C_{W,drinking} / BW) \end{aligned}$$

Where $C_{F,non-cancer}$ is the RBC in the fish and $C_{W,non-cancer}$ is the RBC in the river water that would reflect a hazard index of 1. Equation 3 can then be rewritten to calculate the water RBC as:

$$C_{W,non-cancer} = (RfD \cdot BW - CR_{water} \cdot C_{W,drinking}) / BCF \cdot CR_{fish} \quad (4)$$

We note that a high enough $C_{W,drinking}$ could present a risk from drinking that is larger than the defined overall risk level. Risk based Concentrations calculated for non-cancer risk are given in Table A2 of the Appendix section.

Evaluation of Water Quality Guidelines

To evaluate the protectiveness of the current environmental quality criteria, the water RBCs are compared with available human health water quality guidelines (HH WQGs). In the present study, both the US EPA and Idaho DEQ (department of Environmental Quality) HH WQGs (organism + water) are evaluated.

Risk Quotients

The risk quotient (RQ) is a metric to evaluate the protectiveness of available environmental quality criteria, where:

$$RQ = \text{HH WQG} / \text{RBC} \quad (5)$$

A risk quotient of less than 1 indicates that the environmental quality guideline for the chemical is protective at the risk level defined by the risk based concentration (i.e. 1.10^{-6} for carcinogenic risk, a hazard index of 1 for non-carcinogenic risk) specific for eating Chinook or Sockeye fish at different migration routes.

Results & Discussion:



Guideline values are shown in Table 5. Figure 3 illustrates a comparison of guideline values from the US EPA and Idaho DEQ. Figure 3 shows that the mean Idaho DEQ HH WQGs are higher than the mean EPA values. This suggests that the US EPA, on average, have more conservative guideline values based on the chemicals of the present study.

Risk Quotients for carcinogenic risk (CSF based) are displayed in Tables A3 (Chinook) and A4 (Sockeye) in the appendix. For non carcinogenic risk (RfD based), risk quotients are displayed in Tables A5 (Chinook) and A6 (Sockeye). Risk Quotients for each fish/migration path are also illustrated in Figure A1 of the Appendix.

We emphasize that Risk Based water Concentrations are calculated under the assumption of zero chemical uptake from drinking water, due to chemical concentrations for drinking water is currently not available. Risk quotients would increase if there is considerable exposure through drinking water. However, chemical exposure through drinking water is believed to be low for the relatively high K_{ow} chemicals that are studied.

Another consideration to take into account is that biotransformation rate constants were included to improve the model performance (see Figure 1). Assuming zero metabolism would be a more conservative approach and result in lower RBCs and therefore higher Risk Quotients. The author believes that this would be the correct approach to evaluate a single chemical, as there is large variance in the k_{BM} estimates from the EPI SUITE BCFBAF program. These estimates are QSAR (qualitative structure activity relationships) that are not empirically measured. However, when evaluating multiple chemicals (e.g. evaluating the protectiveness of current guideline values, in general, for the consumption of contaminated fish) then adding the k_{BM} estimates from the EPI SUITE BCFBAF program would improve the more general assessment.

Both drinking water concentrations (under "Drinking water" tab) and biotransformation rate constants can be modified. If new data (or more reliable data) is available for each chemical, the evaluator can enter it in the attached Excel spreadsheet.

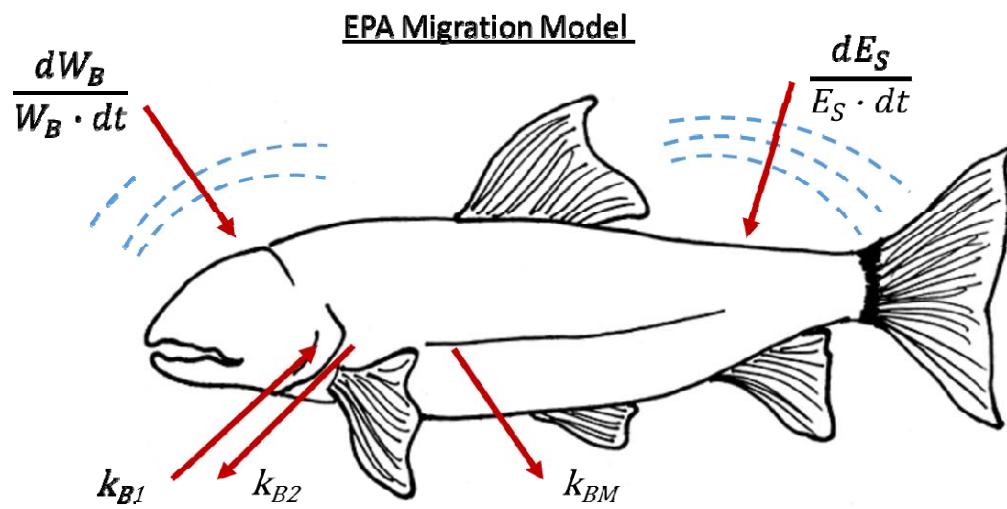
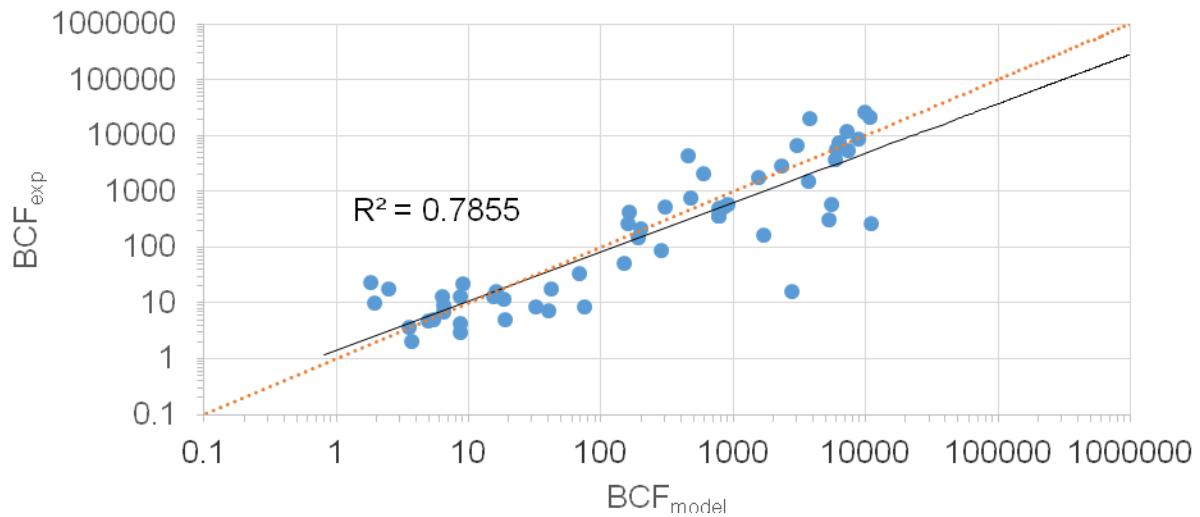


Figure 1. Conceptual diagram of the chemical rate constants in a bioaccumulation fish model designed specifically for migrating fish.

Without metabolism estimates



With metabolism estimates

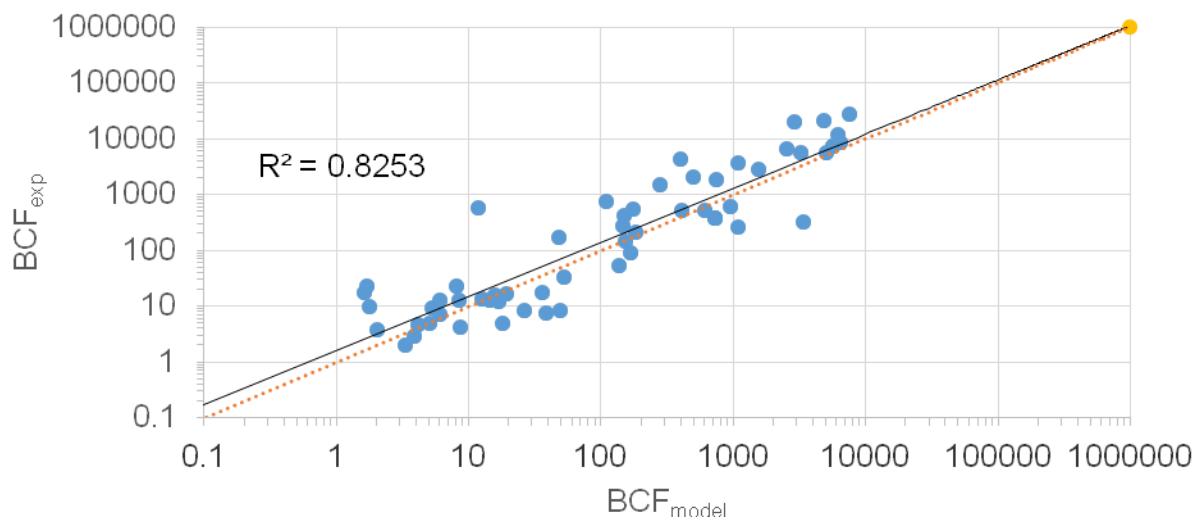


Figure 2. Model assessment without somatic metabolism estimates ($k_{BM} = 0$) and with somatic metabolism estimates (k_{BM} estimates from BCBAF QSAR in Epi Suite v 4.11).

HH WQG (water + organism) comparison

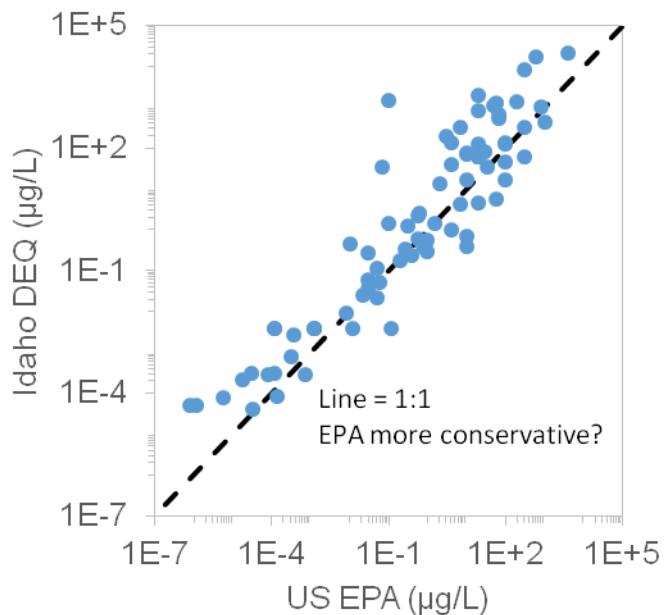


Figure 3. Human Health Water Quality Guideline (water + organism) levels from the Idaho Department of Environmental Quality vs the US Environmental Protection Agency.

Table 1: Exposure time data of migrating salmon

Salmon	Migration	Travel distance (km)	mean swimming speed	Mean travel time (days)
Chinook	Bonneville Dam to Lower Granite Dam	462	0.334 m/sec	16
	Astoria to Lewiston	748		26
	Astoria to Hells Canyon Dam	1146		40
	Astoria to Upper Salmon River	1738		60
Sockeye, Male	Astoria to Wenatchee River	832	0.209 m/sec	46
	Astoria to Redfish Lake	1448		80
Sockeye, Female	Astoria to Wenatchee River	832	0.209 m/sec	46
	Astoria to Redfish Lake	1448		80

Table 2: Body composition data of migrating salmon

Salmon	Body composition change over migration					
	Lipid			Bodyweight		
	Start (day 0)	End	dE _S /E _S dt	Start (day 0)	End	dW _S /W _S dt
Chinook	0.165	0.026 (day 30)	-0.0616	18 kg	N/A	-0.00335*
Sockeye, Male	0.129	0.026 (day 80)	-0.02	1.44 kg	1.21 kg (day 80)	-0.0022
Sockeye, Female	0.131	0.037 (day 80)	-0.0158	1.38 kg	0.96 kg (day 80)	-0.0045

* estimated as equal to the average of Sockeye Males and Females

Table 3: Chemicals evaluated in this study and their CAS numbers, log K_{ow} values, empirical bioconcentration factors (BCF_{exp}), cancer slope factors (CSF), and reference dose (RfD).

Chemical Name	CAS	log K _{ow}	BCF _{exp}	CSF	RfD
Acenaphthene	83329	3.92	755.0922277		0.06
Acrolein		-0.01			0.0005
Acrylonitrile	107131	0.25		0.54	
Aldrin	309002	6.5	5500.472529	17	3E-05
alpha-BHC	319846	4.14	371.5352291	6.3	0.008
alpha-Endosulfan	959988	3.83			0.006
Anthracene	120127	4.45	1800.943134		0.3
Benzene	71432	2.13	4.265795188	0.015	0.0005
Benzidine	92875	1.34		230	0.003
Benzo(a) Anthracene	56553	5.76	260.0159563	0.73	
Benzo(a) Pyrene	50328	6.13		7.3	
Benzo(b) Fluoranthene	205992	5.78		0.73	
Benzo(k) Fluoranthene	207089	6.11		0.073	
beta-BHC	319857	4.14	371.5352291	1.8	
beta-Endosulfan	33213659	3.83		-	0.006
Bis(Chloromethyl) Ether	542881	0.58			
Bis(2-Chloroethyl) Ether	111444	1.29	10	1.1	
** Bis(2-Chloro-1-Methylethyl) Ether	108601	2.48	12.0005182	-	0.04
Bis(2-Ethylhexyl) Phthalate	117817	7.6	588.0306995	0.014	0.06
Bromoform	75252	2.4	13.39985195	0.0045	0.03
Butylbenzyl Phthalate	85687	4.73	16.32675967	0.0019	1.3
Carbon Tetrachloride	56235	2.83	7.399459543	0.07	0.004
Chlordane	57749	6.22	26785.51495	0.35	0.0005
Chlorobenzene	108907	2.84	17.7827941	-	0.02
Chlorodibromomethane	124481	2.16		0.04	0.02
Chloroform	67663	1.97	12.99870237	-	0.01
Chlorophenoxy Herbicide (2,4-D)	94757	2.81			
Chlorophenoxy Herbicide (2,4,5-TP)	93721	3.8			
Chrysene	218019	5.81		0.0073	
Cyanide	57125	-0.25		-	0.0006
Dibenzo(a,h)Anthracene	53703	6.54		7.3	
Dichlorobromomethane	75274	2		0.034	0.003
Dieldrin	60571	5.2	7479.972479	16	5E-05
Diethyl Phthalate	84662	2.42		-	0.8
Dimethyl Phthalate	131113	1.6		-	10
Di-n-Butyl Phthalate	84742	4.5	166.9936664	-	0.1

Dinitrophenols	25550587	1.37			
Endosulfan Sulfate	1031078	3.66		-	0.006
Endrin	72208	5.2	7479.972479	-	0.0003
Endrin Aldehyde	7421934	4.8		-	0.0003
Ethylbenzene	100414	3.15		-	0.022
Fluoranthene	206440	5.16	3630.780548	-	0.04
Fluorene	86737	4.18	525.2910485	-	0.04
gamma-BHC (Lindane)	58899	4.14	371.5352291	-	0.0047
Heptachlor	76448	5.47	8765.970403	4.1	0.0001
Heptachlor Epoxide	1024573	4.98		5.5	1E-05
Hexachlorobenzene	118741	5.73	21428.90601	1.02	0.0008
Hexachlorobutadiene	87683	4.78	6629.793477	0.04	0.0003
Hexachlorocyclo-hexane-Technical	608731	4.14	371.5352291		
Hexachlorocyclopentadiene	77474	5.04		-	0.006
Hexachloroethane	67721	4.14	510.035024	0.04	0.0007
Ideno(1,2,3-cd)Pyrene	193395	6.7		0.73	
Isophorone	78591	1.7	1.99986187	0.00095	0.2
Methoxychlor	72435	5.08	314.9923453		
Methyl Bromide	74839	1.19		-	0.02
Methylene Chloride	75092	1.25	23.0993628	0.002	0.006
Nitrobenzene	98953	1.85	4.700023182	-	0.002
Pentachlorobenzene	608935	5.17	5655.877571		
Pentachlorophenol	87865	5.12	595.9365193	0.4	0.005
Phenol	108952	1.46	17.37800829	-	0.6
Pyrene	129000	4.88	1506.607066	-	0.03
Tetrachloroethylene	127184	3.4	51.99959965	0.0021	0.006
Toluene	108883	2.73	8.317637711	-	0.0097
Toxaphene	8001352	5.78		1.1	0.0004
Trichloroethylene	79016	2.42	15.99926383	0.05	0.0005
Vinyl Chloride	75014	1.62		1.5	0.003
1,1,1-Trichloroethane	71556	2.49	5.00034535	-	2
1,1,2,2-Tetrachloroethane	79345	2.39	12.99870237	0.2	0.02
1,1,2-Trichloroethane	79005	1.89	5.00034535	0.057	0.004
1,1-Dichloroethylene	75354	2.13	12.99870237	-	0.05
1,2,4-Trichlorobenzene	120821	4.02	2084.97091	0.029	0.01
1,2,4,5-Tetrachlorobenzene-	95943	4.64	2775.236508		
1,2-Dichlorobenzene	95501	3.43	270.0225287	-	0.3
1,2-Dichloroethane	107062	1.48		0.0033	0.078
1,2-Dichloropropane	78875	1.98	7.000031591	0.036	0.0893
1,2-Diphenylhydrazine	122667	2.94		0.8	
1,2-Trans-Dichloroethylene	156605	2		-	0.02

1,3-Dichlorobenzene	541731	3.53	214.4865185	-	0.002
1,3-Dichloropropene	542756	2.03		0.122	0.025
1,4-Dichlorobenzene	106467	3.44	419.9523347	-	0.07
2,4,5-Trichlorophenol-	95954	3.72	533.0893422		
2,4,6-Trichlorophenol	88062	3.69	88.00351117	0.011	0.001
2,4-Dichlorophenol	120832	3.06	33.90002356	-	0.003
Nitrobenzene	105679	2.3		-	0.02
2,4-Dinitrophenol	51285	1.67	3.715352291	-	0.002
2,4-Dinitrotoluene	121142	1.98	9.149555587	0.667	0.002
2-Chloronaphthalene	91587	3.9	4265.795188	-	0.08
2-Chlorophenol	95578	2.15	22.2997503	-	0.005
2-Methyl-4,6-Dinitrophenol	534521	2.13	2.884031503	-	0.0003
3,3'-Dichlorobenzidine	91941	3.51	145.7135705	0.45	
3-Methyl-4-Chlorophenol	59507	3.1	8.499629594	-	0.1
4,4'-DDD	72548	6.02		0.24	0.0005
4,4'-DDE	72559	6.51	12022.64435	0.167	0.0005
4,4'-DDT	50293	6.91	19601.98263	0.34	0.0005

Table 4: Risk model parameters

Parameter	Symbol	Value	Units
Consumption Rate of eating fish	CR _{fish}	0.175	kg/d
Human body weight	BW	80	kg
Consumption Rate of drinking water	CR _{water}	2.5	L/d
Acceptable Risk level (cancer based risk)	R _{total}	1.0E-06	unitless
Hazard Index (non-cancer based risk)	HI	1	Unitless

Table 5: Human Health Water Quality Guideline levels (Water + Organisms).

Chemical Name	HH WQG - Water and Organisms			
	US EPA		Idaho	
	µg/L	mg/L	µg/L	mg/L
Acenaphthene	70	0.07	670	0.67
Acrolein	3	0.003	190	0.19
Acrylonitrile	0.061	6.1E-05	0.051	5.1E-05
Aldrin	7.7E-07	7.7E-10	4.9E-05	4.9E-08
alpha-BHC	0.00036	3.6E-07	0.0026	2.6E-06
alpha-Endosulfan	20	0.02	62	0.062
Anthracene	300	0.3	8300	8.3
Benzene	0.58	0.00058	2.2	0.0022
Benzidine	0.00014	1.4E-07	8.6E-05	8.6E-08
Benzo(a) Anthracene	0.0012	1.2E-06	0.0038	3.8E-06
Benzo(a) Pyrene	0.00012	1.2E-07	0.0038	3.8E-06
Benzo(b) Fluoranthene	0.0012	1.2E-06	0.0038	3.8E-06
Benzo(k) Fluoranthene	0.012	1.2E-05	0.0038	3.8E-06
beta-BHC	0.008	8E-06	0.0091	9.1E-06
beta-Endosulfan	20	0.02	62	0.062
Bis(Chloromethyl) Ether	0.00015	1.5E-07		
Bis(2-Chloroethyl) Ether	0.03	0.00003	0.03	0.00003
** Bis(2-Chloro-1-Methylethyl) Ether	200	0.2	1400	1.4
Bis(2-Ethylhexyl) Phthalate	0.32	0.00032	1.2	0.0012
Bromoform	7	0.007	4.3	0.0043
Butylbenzyl Phthalate	0.1	0.0001	1500	1.5
Carbon Tetrachloride	0.4	0.0004	0.23	0.00023
Chlordane	0.00031	3.1E-07	0.0008	8E-07
Chlorobenzene	100	0.1	130	0.13
Chlorodibromomethane	0.8	0.0008	0.4	0.0004
Chloroform	60	0.06	5.7	0.0057
Chlorophenoxy Herbicide (2,4-D)	1300	1.3		
Chlorophenoxy Herbicide (2,4,5-TP)	100	0.1		
Chrysene	0.12	0.00012	0.0038	3.8E-06
Cyanide	4	0.004	140	0.14
Dibenzo(a,h)Anthracene	0.00012	1.2E-07	0.0038	3.8E-06
Dichlorobromomethane	0.95	0.00095	0.55	0.00055
Dieldrin	1.2E-06	1.2E-09	5.2E-05	5.2E-08
Diethyl Phthalate	600	0.6	17000	17
Dimethyl Phthalate	2000	2	270000	270

Di-n-Butyl Phthalate	20	0.02	2000	2
Dinitrophenols	10	0.01		
Endosulfan Sulfate	20	0.02	62	0.062
Endrin	0.03	0.00003	0.059	5.9E-05
Endrin Aldehyde	1	0.001	0.29	0.00029
Ethylbenzene	68	0.068	530	0.53
Fluoranthene	20	0.02	130	0.13
Fluorene	50	0.05	1100	1.1
gamma-BHC (Lindane)	4.2	0.0042	0.98	0.00098
Heptachlor	5.9E-06	5.9E-09	7.9E-05	7.9E-08
Heptachlor Epoxide	3.2E-05	3.2E-08	3.9E-05	3.9E-08
Hexachlorobenzene	7.9E-05	7.9E-08	0.00028	2.8E-07
Hexachlorobutadiene	0.01	0.00001	0.44	0.00044
Hexachlorocyclo-hexane-Technical	0.0066	6.6E-06		
Hexachlorocyclopentadiene	4	0.004	40	0.04
Hexachloroethane	0.1	0.0001	1.4	0.0014
Ideno(1,2,3-cd)Pyrene	0.0012	1.2E-06	0.0038	3.8E-06
Isophorone	34	0.034	35	0.035
Methoxychlor	0.02	0.00002		
Methyl Bromide	100	0.1	47	0.047
Methylene Chloride	20	0.02	4.6	0.0046
Nitrobenzene	10	0.01	17	0.017
Pentachlorobenzene	0.1	0.0001		
Pentachlorophenol	0.03	0.00003	0.27	0.00027
Phenol	4000	4	21000	21
Pyrene	20	0.02	830	0.83
Tetrachloroethylene	10	0.01	0.69	0.00069
Toluene	57	0.057	1300	1.3
Toxaphene	0.0007	7E-07	0.00028	2.8E-07
Trichloroethylene	0.6	0.0006	2.5	0.0025
Vinyl Chloride	0.022	2.2E-05	0.025	2.5E-05
1,1,1-Trichloroethane	10000	10		
1,1,2,2-Tetrachloroethane	0.2	0.0002	0.17	0.00017
1,1,2-Trichloroethane	0.55	0.00055	0.59	0.00059
1,1-Dichloroethylene	300	0.3	330	0.33
1,2,4-Trichlorobenzene	0.071	7.1E-05	35	0.035
1,2,4,5-Tetrachlorobenzene-	0.03	0.00003		
1,2-Dichlorobenzene	1000	1	420	0.42
1,2-Dichloroethane	9.9	0.0099	0.38	0.00038
1,2-Dichloropropane	0.9	0.0009	0.5	0.0005
1,2-Diphenylhydrazine	0.03	0.00003	0.036	3.6E-05

1,2-Trans-Dichloroethylene	100	0.1	140	0.14
1,3-Dichlorobenzene	7	0.007	320	0.32
1,3-Dichloropropene	0.27	0.00027	0.34	0.00034
1,4-Dichlorobenzene	300	0.3	63	0.063
2,4,5-Trichlorophenol-	300	0.3		
2,4,6-Trichlorophenol	1.5	0.0015	1.4	0.0014
2,4-Dichlorophenol	10	0.01	77	0.077
Nitrobenzene	100	0.1	17	0.017
2,4-Dinitrophenol	10	0.01	69	0.069
2,4-Dinitrotoluene	0.049	4.9E-05	0.11	0.00011
2-Chloronaphthalene	800	0.8	1000	1
2-Chlorophenol	30	0.03	81	0.081
2-Methyl-4,6-Dinitrophenol	2	0.002	13	0.013
3,3'-Dichlorobenzidine	0.049	4.9E-05	0.021	2.1E-05
3-Methyl-4-Chlorophenol	500	0.5		
4,4'-DDD	0.00012	1.2E-07	0.00031	3.1E-07
4,4'-DDE	1.8E-05	1.8E-08	0.00022	2.2E-07
4,4'-DDT	0.00003	3E-08	0.00031	3.1E-07

References:

- 1) Lo, J. C.; Campbell, D. A.; Kennedy, C. J.; Gobas, F. A. P. C. Somatic and gastro-intestinal in vivo biotransformation rates of hydrophobic chemicals in fish. *Environ. Toxicol. Chem.* 2015, DOI: 10.1002/etc.3050
- 2) US Environmental Protection Agency. 2012. Estimation Programs Interface Suite for Microsoft Windows v 4.11. Washington, DC
- 3) DeBruyn, A. M. H.; Ikonomou, M.G.; Gobas, F.A.P.C. Magnification and toxicity of PCBs, PCDDs, and PCDFs in upriver-migrating pacific salmon. *Environ. Sci Technol.* 2014, 38, 6217-6224
- 4) Brett, J.R. *Physiological Ecology of Pacific Salmon*; Groot, C., Margolis, L., Clarke, W. C., Eds.; UBC Press: Vancouver, 1995.

Appendix

Table A1. Temporal Bioconcentration Factors calculated for chemicals in the present study for Chinook and Sockeye Salmon in various migration pathways. BCFs were calculated with metabolism (k_{BM} estimates from EPI SUITE v 4.11) and without metabolism ($k_{BM} = 0$). Darker cells indicate higher BCF values.

Chemical Name	Temporal Bioconcentration Factor															
	Chinook, site A		Chinook, site B		Chinook, site C		Chinook, site D		Sockeye M, site E		Sockeye M, site F		Sockeye F, site E		Sockeye F, site F	
	with k_{BM}	no k_{BM}	with k_{BM}	no k_{BM}	with k_{BM}	no k_{BM}	with k_{BM}	no k_{BM}	with k_{BM}	no k_{BM}	with k_{BM}	no k_{BM}	with k_{BM}	no k_{BM}	with k_{BM}	no k_{BM}
Acenaphthene	74.2238	1377.62	74.0329	652.578	74.2288	3136.51	74.2288	9034.57	81.2206	1492.84	81.2206	1739.37	81.4156	1467.06	81.4156	1690.12
Acrolein	0.17845	0.88176	0.17845	0.87931	0.17845	0.88183	0.17845	0.88183	0.21485	0.8457	0.21485	0.8457	0.2154	0.84364	0.2154	0.84364
Acrylonitrile	0.2844	0.99005	0.2844	0.98997	0.2844	0.99005	0.2844	0.99005	0.33346	0.95043	0.33346	0.95043	0.3344	0.95062	0.3344	0.95062
Aldrin	539.829	549.112	226.954	229.171	1481.92	1524.9	5833.34	6118.73	1492.46	1572.32	3922.96	4332.46	1440.14	1517.08	3618.1	3992.91
alpha-BHC	1404.19	1546.45	659.786	697.595	3237.72	3800.4	9525.7	12439.1	1832.05	2300.61	2324.65	3299.93	1790.38	2244.97	2232.2	3146.13
alpha-Endosulfan	968.966	1289.01	530.384	627.548	1768.3	2812.62	3528.83	7545.59	760.257	1207.4	774.352	1319.85	752.813	1190.85	765.382	1292.8
Anthracene	904.829	1682.59	507.664	729.788	1591.71	4397.82	2992.99	15954.2	879.421	3406.75	909.107	6464.11	863.919	3305.03	889.731	6054.53
Benzene	24.4896	27.0885	24.4893	27.0875	24.4896	27.0885	24.4896	27.0885	18.4118	19.5046	18.4118	19.5046	18.6414	19.7575	18.6414	19.7575
Benzidine	3.56624	4.70471	3.56624	4.70471	3.56624	4.70471	3.56624	4.70471	3.11851	3.73195	3.11851	3.73195	3.14863	3.77197	3.14863	3.77197
Benzo(a) Anthracene	763.041	1302.1	399.333	544.286	1490.02	3606.99	3323.05	14413.5	935.941	3672.85	1049.8	9950.11	912.258	3544.57	1011.47	9175.81
Benzo(a) Pyrene	198.252	924.136	150.63	385.869	235.008	2564.45	258.54	10277.2	170.28	2634.28	170.301	7221.81	169.18	2541.89	169.198	6657
Benzo(b) Fluoranthene	702.933	1283.79	378.161	536.588	1316.56	3556.76	2741.26	14216.1	807.586	3624.2	874.746	9827.44	788.586	3497.58	846.899	9062.39
Benzo(k) Fluoranthene	583.042	945.736	298.541	394.903	1177.09	2624.23	2774.12	10515.8	760.033	2694.86	884.815	7384.79	739.661	2600.36	848.668	6807.35
beta-BHC	1404.19	1546.45	659.786	697.595	3237.72	3800.4	9525.7	12439.1	1832.05	2300.61	2324.65	3299.93	1790.38	2244.97	2232.2	3146.13
beta-Endosulfan	968.966	1289.01	530.384	627.548	1768.3	2812.62	3528.83	7545.59	760.257	1207.4	774.352	1319.85	752.813	1190.85	765.382	1292.8
Bis(Chloromethyl) Ether	0.69411	1.34147	0.69411	1.34147	0.69411	1.34147	0.69411	1.34147	0.73794	1.22691	0.73794	1.22691	0.74085	1.23149	0.74085	1.23149
Bis(2-Chloroethyl) Ether	2.97052	4.2573	2.97052	4.2573	2.97052	4.2573	2.97052	4.2573	2.68089	3.40169	2.68089	3.40169	2.70528	3.4371	2.70528	3.4371
** Bis(2-Chloro-1-Methylethyl) Ether	37.9779	64.7303	37.9742	64.4525	37.9779	64.7403	37.9779	64.7404	31.5997	43.1209	31.5997	43.1209	31.9278	43.6656	31.9278	43.6656
Bis(2-Ethylhexyl) Phthalate	8.71593	59.633	7.40098	24.8797	9.3501	165.687	9.56022	665.389	7.83637	171.28	7.8364	473.606	7.80935	165.255	7.80938	436.434
Bromoform	19.3386	52.6525	19.3386	52.5649	19.3386	52.6542	19.3386	52.6542	18.7728	35.9027	18.7728	35.9027	18.9361	36.3615	18.9361	36.3615
Butylbenzyl Phthalate	9.29714	1725.46	9.29714	734.799	9.29714	4641.77	9.29714	17667.1	11.7445	4098.48	11.7445	9184.21	11.7903	3965.6	11.7903	8533.53
Carbon Tetrachloride	109.259	171.929	106.676	158.027	109.55	175.843	109.563	176.46	77.1288	97.3087	77.1288	97.3087	77.8837	98.4026	77.8837	98.4026

Chlordane	816.465	827.406	342.815	345.427	2245.88	2296.59	8870.41	9207.47	2267.79	2362.01	6002.11	6486.15	2188.35	2279.13	5535.46	5978.53
Chlorobenzene	74.9465	177.061	74.5961	161.924	74.9598	181.52	74.9599	182.268	61.961	99.6308	61.961	99.6308	62.491	100.745	62.491	100.745
Chlorodibromomethane	15.812	29.1063	15.812	29.1046	15.812	29.1063	15.812	29.1063	14.2084	20.8585	14.2084	20.8585	14.353	21.1289	14.353	21.1289
Chloroform	14.3897	18.5924	14.3897	18.5924	14.3897	18.5924	14.3897	18.5924	11.7263	13.6844	11.7263	13.6844	11.8625	13.8603	11.8625	13.8603
Chlorophenoxy Herbicide (2,4-D)	152.42	162.125	142.894	150.448	154.607	165.122	154.868	165.538	90.1244	92.8313	90.1244	92.8313	91.1298	93.8862	91.1298	93.8862
Chlorophenoxy Herbicide (2,4,5-TP)	1167.22	1256.96	592.028	618.263	2390.92	2699.43	5772.5	7052.1	987.637	1120.89	1036.72	1204.61	976.298	1106.94	1020.63	1182.88
Chrysene	748.756	1255.71	389	524.785	1478.5	3479.63	3358.68	13912.3	936.378	3549.06	1062.31	9636.37	912.226	3425	1022.05	8885.78
Cyanide	0.03562	0.87868	0.03562	0.85246	0.03562	0.88215	0.03562	0.88235	0.04509	0.79877	0.04509	0.79877	0.04525	0.79473	0.04525	0.79473
Dibenzo(a,h)Anthracene	323.5	514	164.154	214.51	662.221	1427.47	1597.09	5728.21	433.301	1472.21	513.705	4057.97	421.418	1420.48	491.729	3739.89
Dichlorobromomethane	13.5426	19.9353	13.5426	19.9352	13.5426	19.9353	13.5426	19.9353	11.52	14.6174	11.52	14.6174	11.6473	14.8058	11.6473	14.8058
Dieldrin	1627.24	1654.42	688.532	695.071	4422.07	4546.57	17116.5	17929.1	4232.92	4449.23	10398.9	11424.9	4088.31	4296.82	9616.14	10556.6
Diethyl Phthalate	3.71993	55.4148	3.71993	55.2968	3.71993	55.4175	3.71993	55.4175	4.51646	37.5816	4.51646	37.5816	4.54029	38.0607	4.54029	38.0607
Dimethyl Phthalate	0.89113	8.10845	0.89113	8.10845	0.89113	8.10845	0.89113	8.10845	1.06772	6.22383	1.06772	6.22383	1.07368	6.29844	1.07368	6.29844
Di-n-Butyl Phthalate	24.6996	1695.24	24.6996	732.214	24.6996	4460.03	24.6996	16357.6	30.2503	3556.34	30.2503	6994.95	30.3521	3448.06	30.3521	6539.54
Dinitrophenols	0.89171	4.99949	0.89171	4.99949	0.89171	4.99949	0.89171	4.99949	1.03202	3.9492	1.03202	3.9492	1.0382	3.99225	1.0382	3.99225
Endosulfan Sulfate	780.03	1092.06	464.545	568.429	1258.11	2150.19	2062.73	4861.29	515.399	779.812	516.792	796.15	513.529	774.819	514.771	789.687
Endrin	1627.24	1654.42	688.532	695.071	4422.07	4546.57	17116.5	17929.1	4232.92	4449.23	10398.9	11424.9	4088.31	4296.82	9616.14	10556.6
Endrin Aldehyde	1645.98	1726.14	713.199	732.859	4308.89	4665.85	15672.5	17900.5	3670.83	4214	7542.36	9726.88	3551.7	4075.61	7018.81	9026.21
Ethylbenzene	78.4753	426.176	78.1273	312.167	78.488	525.645	78.4882	601.399	74.1167	209.638	74.1167	209.638	74.5333	211.339	74.5333	211.339
Fluoranthene	894.272	1667.71	487.846	701.125	1640.27	4578.23	3300.4	18022.2	982.691	4456.86	1046.78	11364.5	961.004	4304.58	1016.61	10503.6
Fluorene	548.263	1570.22	373.309	703.6	737.864	3899.44	934.603	12988.6	435.847	2453.51	436.233	3663.1	432.692	2391.79	433.019	3482.05
gamma-BHC (Lindane)	1404.19	1546.45	659.786	697.595	3237.72	3800.4	9525.7	12439.1	1832.05	2300.61	2324.65	3299.93	1790.38	2244.97	2232.2	3146.13
Heptachlor	1473.4	1524.39	626.099	638.374	3977.22	4210.62	15223.9	16745.3	3813.66	4226.02	9246.59	11227.4	3682.11	4079.44	8546.8	10361.1
Heptachlor Epoxide	1626.24	1710.18	701.338	721.804	4288.8	4665.93	15792.8	18179.9	3799.92	4407.02	8190.59	10792.9	3673.49	4258.77	7603.3	9991.06
Hexachlorobenzene	1228.06	1328.9	531.077	555.567	3224.74	3680.44	11789.3	14701.7	2956.33	3743.55	6499.13	10126.7	2854.71	3612.87	6018.39	9339.14
Hexachlorobutadiene	1620.79	1726.34	707.537	733.544	4193.52	4660.37	14957.8	17841.2	3487.94	4183.35	6863.81	9578.8	3375.7	4046.44	6396.42	8891.85
Hexachlorocyclo-hexane-Technical	1404.19	1546.45	659.786	697.595	3237.72	3800.4	9525.7	12439.1	1832.05	2300.61	2324.65	3299.93	1790.38	2244.97	2232.2	3146.13
Hexachlorocyclopentadiene	1519.24	1699.07	671.637	716.049	3853.52	4646.52	13297.4	18175	3208.82	4439.15	6076.73	11038.4	3103.46	4288.92	5661.1	10212.2
Hexachloroethane	1121.07	1546.45	578.484	697.595	2236.73	3800.4	5169.15	12439.1	1153.64	2300.61	1247.29	3299.93	1132.26	2244.97	1215.23	3146.13
Ieno(1,2,3-cd)Pyrene	110.975	388.291	76.4764	162.032	147.126	1078.52	182.875	4329.06	95.8365	1113.2	95.9554	3071.68	94.8841	1074.07	94.9835	2830.8

Isophorone	6.06075	10.0896	6.06075	10.0896	6.06075	10.0896	6.06075	10.0896	5.50177	7.65807	5.50177	7.65807	5.557	7.75242	5.557	7.75242
Methoxychlor	1541.2	1690	675.055	711.595	3966.64	4628.15	14024.7	18145.2	3399.65	4451.88	6781.58	11171.5	3286.79	4300.69	6306.02	10331.6
Methyl Bromide	2.11272	3.50552	2.11272	3.50552	2.11272	3.50552	2.11272	3.50552	2.00985	2.84523	2.00985	2.84523	2.02613	2.87284	2.02613	2.87284
Methylene Chloride	2.90833	3.9353	2.90833	3.9353	2.90833	3.9353	2.90833	3.9353	2.59203	3.1636	2.59203	3.1636	2.61554	3.19567	2.61554	3.19567
Nitrobenzene	6.5306	14.1179	6.5306	14.1179	6.5306	14.1179	6.5306	14.1179	6.29677	10.5389	6.29677	10.5389	6.35517	10.6726	6.35517	10.6726
Pentachlorobenzene	1472	1664.52	652.135	699.664	3721.3	4570.74	12769.9	18000.9	3115.29	4455.58	5885.87	11381.8	3012.21	4303.24	5481.06	10518.9
Pentachlorophenol	819.07	1679.56	464.466	706.627	1418.41	4605.41	2600.79	18094.2	835.957	4457.76	866.557	11280.1	819.602	4305.89	846.02	10428.7
Phenol	1.5932	6.01974	1.5932	6.01974	1.5932	6.01974	1.5932	6.01974	1.75026	4.69894	1.75026	4.69894	1.76234	4.75242	1.76234	4.75242
Pyrene	203.631	1722.21	183.165	729.053	210.524	4676.73	211.915	18080.3	189.896	4318	189.896	10260.9	189.552	4174.48	189.552	9510.23
Tetrachloroethylene	505.885	742.299	352.232	448.384	662.231	1173.37	810.473	1865.24	290.808	392.662	290.818	392.846	291.768	393.839	291.776	394.007
Toluene	43.9683	128.508	43.9618	123.02	43.9684	129.453	43.9684	129.529	40.5422	76.95	40.5422	76.95	40.8753	77.8573	40.8753	77.8573
Toxaphene	1250.11	1283.79	528.512	536.588	3401.72	3556.76	13196.1	14216.1	3342.99	3624.2	8430.67	9827.44	3226.65	3497.58	7783.59	9062.39
Trichloroethylene	44.6134	55.4148	44.5916	55.2968	44.6136	55.4175	44.6136	55.4175	33.3297	37.5816	33.3297	37.5816	33.7224	38.0607	33.7224	38.0607
Vinyl Chloride	6.36606	8.46771	6.36606	8.46771	6.36606	8.46771	6.36606	8.46771	5.42028	6.48479	5.42028	6.48479	5.47867	6.563	5.47867	6.563
1,1,1-Trichloroethane	48.0638	66.4491	48.0327	66.1303	48.0641	66.4614	48.0641	66.4615	36.8491	44.1229	36.8491	44.1229	37.2627	44.6793	37.2627	44.6793
1,1,2,2-Tetrachloroethane	37.1533	51.3294	37.1487	51.2541	37.1533	51.3308	37.1533	51.3308	29.1792	35.0924	29.1792	35.0924	29.5104	35.5414	29.5104	35.5414
1,1,2-Trichloroethane	11.9945	15.4649	11.9945	15.4649	11.9945	15.4649	11.9945	15.4649	9.84716	11.4918	9.84716	11.4918	9.96067	11.6383	9.96067	11.6383
1,1-Dichloroethylene	21.3886	27.0885	21.3886	27.0875	21.3886	27.0885	21.3886	27.0885	16.9745	19.5046	16.9745	19.5046	17.1752	19.7575	17.1752	19.7575
1,2,4-Trichlorobenzene	1095.14	1462.62	570.702	675.708	2152.42	3462.69	4852.01	10647.8	1039.06	1847.01	1099.75	2352.03	1022.55	1808.68	1076.5	2264.86
1,2,4,5-Tetrachlorobenzene-	1427.2	1718.87	660.888	735.428	3366.52	4590.07	10289	17257.3	2365.37	3915.87	3490.11	8392.49	2295.88	3791.45	3295.92	7813.56
1,2-Dichlorobenzene	533.871	783.56	364.943	463.823	714.954	1274.84	899.938	2118.46	309.609	424.388	309.627	424.735	310.434	425.293	310.45	425.611
1,2-Dichloroethane	4.73773	6.27742	4.73773	6.27742	4.73773	6.27742	4.73773	6.27742	4.08485	4.88778	4.08485	4.88778	4.12687	4.94389	4.12687	4.94389
1,2-Dichloropropane	14.1051	19.0289	14.1051	19.0288	14.1051	19.0289	14.1051	19.0289	11.6633	13.9882	11.6633	13.9882	11.7966	14.1682	11.7966	14.1682
1,2-Diphenylhydrazine	59.0752	237.619	59.0173	204.695	59.076	252.3	59.076	256.663	55.4048	126.284	55.4048	126.284	55.7908	127.603	55.7908	127.603
1,2-Trans-Dichloroethylene	16.0277	19.9353	16.0277	19.9352	16.0277	19.9353	16.0277	19.9353	12.8351	14.6174	12.8351	14.6174	12.9869	14.8058	12.9869	14.8058
1,3-Dichlorobenzene	631.671	920.978	406.891	512.548	913.763	1639.71	1275.17	3143.61	382.252	551.868	382.388	554.148	382.358	551.208	382.479	553.289
1,3-Dichloropropene	17.0385	21.3831	17.0385	21.3829	17.0385	21.3831	17.0385	21.3831	13.6439	15.6178	13.6439	15.6178	13.8051	15.8195	13.8051	15.8195
1,4-Dichlorobenzene	543.558	797.348	369.262	468.893	733.641	1309.58	932.67	2208.43	316.251	435.575	316.273	436.001	317.023	436.373	317.044	436.763
2,4,5-Trichlorophenol-	241.174	1165.65	210.685	591.113	253.695	2388.44	257.015	5769.5	197.158	913.238	197.158	948.016	197.303	905.026	197.303	936.63
2,4,6-Trichlorophenol	231.841	1129.36	204.358	580.021	242.506	2269.57	245.121	5308.15	190.103	844.159	190.103	868.259	190.301	837.666	190.301	859.583

2,4-Dichlorophenol	86.4396	334.917	85.7798	263.909	86.4741	382.823	86.4746	408.194	76.5566	168.415	76.5566	168.415	77.0568	169.976	77.0568	169.976
Nitrobenzene	11.6841	40.9533	11.6841	40.935	11.6841	40.9535	11.6841	40.9535	12.1234	28.5967	12.1234	28.5967	12.2193	28.9657	12.2193	28.9657
2,4-Dinitrophenol	1.78377	9.44467	1.78377	9.44467	1.78377	9.44467	1.78377	9.44467	2.03142	7.19248	2.03142	7.19248	2.04462	7.28043	2.04462	7.28043
2,4-Dinitrotoluene	8.41342	19.0289	8.41342	19.0288	8.41342	19.0289	8.41342	19.0289	8.13039	13.9882	8.13039	13.9882	8.20558	14.1682	8.20558	14.1682
2-Chloronaphthalene	1038.47	1358.92	552.906	647.373	1975.69	3066.8	4220.77	8704.58	883.934	1426.29	913.473	1635.91	872.96	1402.74	899.296	1592.49
2-Chlorophenol	15.9955	28.4162	15.9955	28.4147	15.9955	28.4162	15.9955	28.4162	14.2339	20.3967	14.2339	20.3967	14.3808	20.6611	14.3808	20.6611
2-Methyl-4,6-Dinitrophenol	2.87936	27.0885	2.87936	27.0875	2.87936	27.0885	2.87936	27.0885	3.42026	19.5046	3.42026	19.5046	3.44003	19.7575	3.44003	19.7575
3,3'-Dichlorobenzidine	363.016	893.688	282.8	503.173	419.555	1564	451.401	2916.51	245.263	523.418	245.264	525.028	245.733	523.169	245.734	524.639
3-Methyl-4-Chlorophenol	58.1725	373.598	58.1302	285.069	58.173	440.909	58.173	483.099	58.1223	185.561	58.1223	185.561	58.4523	187.192	58.4523	187.192
4,4'-DDD	1012.58	1042.45	428.212	435.373	2754.1	2891.69	10675.8	11581.5	2713.88	2964.83	6853.72	8107.28	2619.19	2860.95	6326.43	7473.91
4,4'-DDE	536.542	540.203	224.579	225.451	1483.17	1500.18	5906.06	6019.65	1515.01	1546.92	4096.64	4262.86	1461.83	1492.58	3776.61	3928.75
4,4'-DDT	257.238	259.981	107.825	108.479	709.487	722.22	2814.67	2899.56	722.101	745.949	1936.39	2060.2	696.744	719.721	1785.26	1898.58

Table A2. Risk based Concentrations calculated based on the Cancer Slope Factor, CSF (cancer-based risk) and the reference dose, RfD (non cancer-based risk) for chemicals in the present study.

Chemical Name	Risk Based Concentrations (river water), assuming chemical concentration in drinking water = 0															
	Chinook, site A		Chinook, site B		Chinook, site C		Chinook, site D		Sockeye M, site E		Sockeye M, site F		Sockeye F, site E		Sockeye F, site F	
	CSF	RfD	CSF	RfD	CSF	RfD	CSF	RfD	CSF	RfD	CSF	RfD	CSF	RfD	CSF	RfD
Acenaphthene	no CSF	0.36954	no CSF	0.37049	no CSF	0.36951	no CSF	0.36951	no CSF	0.3377	no CSF	0.3377	no CSF	0.3369	no CSF	0.3369
Acrolein	no CSF	1.28084	no CSF	1.28084	no CSF	1.28084	no CSF	1.28084	no CSF	1.06388	no CSF	1.06388	no CSF	1.06117	no CSF	1.06117
Acrylonitrile	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD
Aldrin	5E-08	2.5E-05	1.2E-07	6E-05	1.8E-08	9.3E-06	4.6E-09	2.4E-06	1.8E-08	9.2E-06	6.9E-09	3.5E-06	1.9E-08	9.5E-06	7.4E-09	3.8E-06
alpha-BHC	5.2E-08	0.0026	1.1E-07	0.00554	2.2E-08	0.00113	7.6E-09	0.00038	4E-08	0.002	3.1E-08	0.00157	4.1E-08	0.00204	3.3E-08	0.00164
alpha-Endosulfan	no CSF	0.00283	no CSF	0.00517	no CSF	0.00155	no CSF	0.00078	no CSF	0.00361	no CSF	0.00354	no CSF	0.00364	no CSF	0.00358
Anthracene	no CSF	0.15157	no CSF	0.27014	no CSF	0.08616	no CSF	0.04582	no CSF	0.15595	no CSF	0.15085	no CSF	0.15874	no CSF	0.15414
Benzene	0.00124	0.00933	0.00124	0.00933	0.00124	0.00933	0.00124	0.00933	0.00166	0.01241	0.00166	0.01241	0.00163	0.01226	0.00163	0.01226
Benzidine	5.6E-07	0.38456	5.6E-07	0.38456	5.6E-07	0.38456	5.6E-07	0.38456	6.4E-07	0.43977	6.4E-07	0.43977	6.3E-07	0.43556	6.3E-07	0.43556
Benzo(a) Anthracene	8.2E-07	no RfD	1.6E-06	no RfD	4.2E-07	no RfD	1.9E-07	no RfD	6.7E-07	no RfD	6E-07	no RfD	6.9E-07	no RfD	6.2E-07	no RfD
Benzo(a) Pyrene	3.2E-07	no RfD	4.2E-07	no RfD	2.7E-07	no RfD	2.4E-07	no RfD	3.7E-07	no RfD						
Benzo(b) Fluoranthene	8.9E-07	no RfD	1.7E-06	no RfD	4.8E-07	no RfD	2.3E-07	no RfD	7.8E-07	no RfD	7.2E-07	no RfD	7.9E-07	no RfD	7.4E-07	no RfD
Benzo(k) Fluoranthene	1.1E-05	no RfD	2.1E-05	no RfD	5.3E-06	no RfD	2.3E-06	no RfD	8.2E-06	no RfD	7.1E-06	no RfD	8.5E-06	no RfD	7.4E-06	no RfD
beta-BHC	1.8E-07	no RfD	3.8E-07	no RfD	7.8E-08	no RfD	2.7E-08	no RfD	1.4E-07	no RfD	1.1E-07	no RfD	1.4E-07	no RfD	1.1E-07	no RfD
beta-Endosulfan	no CSF	0.00283	no CSF	0.00517	no CSF	0.00155	no CSF	0.00078	no CSF	0.00361	no CSF	0.00354	no CSF	0.00364	no CSF	0.00358
Bis(Chloromethyl) Ether	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD	no CSF	no RfD
Bis(2-Chloroethyl) Ether	0.00014	no RfD	0.00014	no RfD	0.00014	no RfD	0.00014	no RfD	0.00016	no RfD	0.00016	no RfD	0.00015	no RfD	0.00015	no RfD
** Bis(2-Chloro-1-Methylethyl) Ether	no CSF	0.48148	no CSF	0.48153	no CSF	0.48148	no CSF	0.48148	no CSF	0.57867	no CSF	0.57867	no CSF	0.57272	no CSF	0.57272
Bis(2-Ethylhexyl) Phthalate	0.00375	3.14695	0.00441	3.70607	0.00349	2.93351	0.00342	2.86903	0.00417	3.50016	0.00417	3.50015	0.00418	3.51227	0.00418	3.51226
Bromoform	0.00525	0.70917	0.00525	0.70917	0.00525	0.70917	0.00525	0.70917	0.00541	0.73054	0.00541	0.73054	0.00536	0.72424	0.00536	0.72424
Butylbenzyl Phthalate	0.02588	63.9213	0.02588	63.9213	0.02588	63.9213	0.02588	63.9213	0.02049	50.6011	0.02049	50.6011	0.02041	50.4047	0.02041	50.4047
Carbon Tetrachloride	6E-05	0.01674	6.1E-05	0.01714	6E-05	0.01669	6E-05	0.01669	8.5E-05	0.02371	8.5E-05	0.02371	8.4E-05	0.02348	8.4E-05	0.02348
Chlordane	1.6E-06	0.00028	3.8E-06	0.00067	5.8E-07	0.0001	1.5E-07	2.6E-05	5.8E-07	0.0001	2.2E-07	3.8E-05	6E-07	0.0001	2.4E-07	4.1E-05

Chlorobenzene	no CSF	0.12199	no CSF	0.12256	no CSF	0.12197	no CSF	0.12197	no CSF	0.14756	no CSF	0.14756	no CSF	0.14631	no CSF	0.14631
Chlorodibromomethane	0.00072	0.57822	0.00072	0.57822	0.00072	0.57822	0.00072	0.57822	0.0008	0.64348	0.0008	0.64348	0.0008	0.637	0.0008	0.637
Chloroform	no CSF	0.31769	no CSF	0.38985	no CSF	0.38985	no CSF	0.38537	no CSF	0.38537						
Chlorophenoxy Herbicide (2,4-D)	no CSF	no RfD														
Chlorophenoxy Herbicide (2,4,5-TP)	no CSF	no RfD														
Chrysene	8.4E-05	no RfD	0.00016	no RfD	4.2E-05	no RfD	1.9E-05	no RfD	6.7E-05	no RfD	5.9E-05	no RfD	6.9E-05	no RfD	6.1E-05	no RfD
Cyanide	no CSF	7.70053	no CSF	6.08368	no CSF	6.08368	no CSF	6.06105	no CSF	6.06105						
Dibenzo(a,h)Anthracene	1.9E-07	no RfD	3.8E-07	no RfD	9.5E-08	no RfD	3.9E-08	no RfD	1.4E-07	no RfD	1.2E-07	no RfD	1.5E-07	no RfD	1.3E-07	no RfD
Dichlorobromomethane	0.00099	0.10127	0.00099	0.10127	0.00099	0.10127	0.00099	0.10127	0.00117	0.11905	0.00117	0.11905	0.00115	0.11775	0.00115	0.11775
Dieldrin	1.8E-08	1.4E-05	4.1E-08	3.3E-05	6.5E-09	5.2E-06	1.7E-09	1.3E-06	6.7E-09	5.4E-06	2.7E-09	2.2E-06	7E-09	5.6E-06	3E-09	2.4E-06
Diethyl Phthalate	no CSF	98.3121	no CSF	80.9737	no CSF	80.9737	no CSF	80.5487	no CSF	80.5487						
Dimethyl Phthalate	no CSF	5129.95	no CSF	4281.5	no CSF	4281.5	no CSF	4257.73	no CSF	4257.73						
Di-n-Butyl Phthalate	no CSF	1.85081	no CSF	1.5112	no CSF	1.5112	no CSF	1.50613	no CSF	1.50613						
Dinitrophenols	no CSF	no RfD														
Endosulfan Sulfate	no CSF	0.00352	no CSF	0.0059	no CSF	0.00218	no CSF	0.00133	no CSF	0.00532	no CSF	0.00531	no CSF	0.00534	no CSF	0.00533
Endrin	no CSF	8.4E-05	no CSF	0.0002	no CSF	3.1E-05	no CSF	8E-06	no CSF	3.2E-05	no CSF	1.3E-05	no CSF	3.4E-05	no CSF	1.4E-05
Endrin Aldehyde	no CSF	8.3E-05	no CSF	0.00019	no CSF	3.2E-05	no CSF	8.8E-06	no CSF	3.7E-05	no CSF	1.8E-05	no CSF	3.9E-05	no CSF	2E-05
Ethylbenzene	no CSF	0.12816	no CSF	0.12873	no CSF	0.12814	no CSF	0.12814	no CSF	0.13569	no CSF	0.13569	no CSF	0.13493	no CSF	0.13493
Fluoranthene	no CSF	0.02045	no CSF	0.03748	no CSF	0.01115	no CSF	0.00554	no CSF	0.01861	no CSF	0.01747	no CSF	0.01903	no CSF	0.01799
Fluorene	no CSF	0.03335	no CSF	0.04898	no CSF	0.02478	no CSF	0.01957	no CSF	0.04195	no CSF	0.04192	no CSF	0.04226	no CSF	0.04223
gamma-BHC (Lindane)	no CSF	0.00153	no CSF	0.00326	no CSF	0.00066	no CSF	0.00023	no CSF	0.00117	no CSF	0.00092	no CSF	0.0012	no CSF	0.00096
Heptachlor	7.6E-08	3.1E-05	1.8E-07	7.3E-05	2.8E-08	1.1E-05	7.3E-09	3E-06	2.9E-08	1.2E-05	1.2E-08	4.9E-06	3E-08	1.2E-05	1.3E-08	5.3E-06
Heptachlor Epoxide	5.1E-08	3.7E-06	1.2E-07	8.5E-06	1.9E-08	1.4E-06	5.3E-09	3.8E-07	2.2E-08	1.6E-06	1E-08	7.3E-07	2.3E-08	1.6E-06	1.1E-08	7.8E-07
Hexachlorobenzene	3.6E-07	0.0003	8.4E-07	0.00069	1.4E-07	0.00011	3.8E-08	3.1E-05	1.5E-07	0.00012	6.9E-08	5.6E-05	1.6E-07	0.00013	7.4E-08	6.1E-05
Hexachlorobutadiene	7.1E-06	8.5E-05	1.6E-05	0.00019	2.7E-06	3.3E-05	7.6E-07	9.2E-06	3.3E-06	3.9E-05	1.7E-06	2E-05	3.4E-06	4.1E-05	1.8E-06	2.1E-05
Hexachlorocyclo-hexane-Technical	no CSF	no RfD														
Hexachlorocyclopentadiene	no CSF	0.00181	no CSF	0.00408	no CSF	0.00071	no CSF	0.00021	no CSF	0.00085	no CSF	0.00045	no CSF	0.00088	no CSF	0.00048
Hexachloroethane	1E-05	0.00029	2E-05	0.00055	5.1E-06	0.00014	2.2E-06	6.2E-05	9.9E-06	0.00028	9.2E-06	0.00026	1E-05	0.00028	9.4E-06	0.00026
Ideno(1,2,3-cd)Pyrene	5.6E-06	no RfD	8.2E-06	no RfD	4.3E-06	no RfD	3.4E-06	no RfD	6.5E-06	no RfD	6.5E-06	no RfD	6.6E-06	no RfD	6.6E-06	no RfD
Isophorone	0.0794	15.0854	0.0794	15.0854	0.0794	15.0854	0.0794	15.0854	0.08746	16.618	0.08746	16.618	0.08659	16.4529	0.08659	16.4529

Methoxychlor	no CSF	no RfD														
Methyl Bromide	no CSF	4.32754	no CSF	4.54903	no CSF	4.54903	no CSF	4.51248	no CSF	4.51248						
Methylene Chloride	0.07859	0.9431	0.07859	0.9431	0.07859	0.9431	0.07859	0.9431	0.08818	1.05819	0.08818	1.05819	0.08739	1.04868	0.08739	1.04868
Nitrobenzene	no CSF	0.14	no CSF	0.1452	no CSF	0.1452	no CSF	0.14386	no CSF	0.14386						
Pentachlorobenzene	no CSF	no RfD														
Pentachlorophenol	1.4E-06	0.00279	2.5E-06	0.00492	8.1E-07	0.00161	4.4E-07	0.00088	1.4E-06	0.00273	1.3E-06	0.00264	1.4E-06	0.00279	1.4E-06	0.0027
Phenol	no CSF	172.16	no CSF	156.712	no CSF	156.712	no CSF	155.637	no CSF	155.637						
Pyrene	no CSF	0.06735	no CSF	0.07487	no CSF	0.06514	no CSF	0.06472	no CSF	0.07222	no CSF	0.07222	no CSF	0.07235	no CSF	0.07235
Tetrachloroethylene	0.00043	0.00542	0.00062	0.00779	0.00033	0.00414	0.00027	0.00338	0.00075	0.00943	0.00075	0.00943	0.00075	0.0094	0.00075	0.0094
Toluene	no CSF	0.10085	no CSF	0.10087	no CSF	0.10085	no CSF	0.10085	no CSF	0.10937	no CSF	0.10937	no CSF	0.10848	no CSF	0.10848
Toxaphene	3.3E-07	0.00013	7.9E-07	0.0003	1.2E-07	4.7E-05	3.1E-08	1.2E-05	1.2E-07	4.8E-05	4.9E-08	1.9E-05	1.3E-07	5E-05	5.3E-08	2.1E-05
Trichloroethylene	0.0002	0.00512	0.00021	0.00513	0.0002	0.00512	0.0002	0.00512	0.00027	0.00686	0.00027	0.00686	0.00027	0.00678	0.00027	0.00678
Vinyl Chloride	4.8E-05	0.21543	4.8E-05	0.21543	4.8E-05	0.21543	4.8E-05	0.21543	5.6E-05	0.25302	5.6E-05	0.25302	5.6E-05	0.25032	5.6E-05	0.25032
1,1,1-Trichloroethane	no CSF	19.0223	no CSF	19.0347	no CSF	19.0222	no CSF	19.0222	no CSF	24.8116	no CSF	24.8116	no CSF	24.5362	no CSF	24.5362
1,1,2,2-Tetrachloroethane	6.2E-05	0.24608	6.2E-05	0.24612	6.2E-05	0.24608	6.2E-05	0.24608	7.8E-05	0.31333	7.8E-05	0.31333	7.7E-05	0.30982	7.7E-05	0.30982
1,1,2-Trichloroethane	0.00067	0.15245	0.00067	0.15245	0.00067	0.15245	0.00067	0.15245	0.00081	0.1857	0.00081	0.1857	0.00081	0.18358	0.00081	0.18358
1,1-Dichloroethylene	no CSF	1.06866	no CSF	1.34656	no CSF	1.34656	no CSF	1.33082	no CSF	1.33082						
1,2,4-Trichlorobenzene	1.4E-05	0.00417	2.8E-05	0.00801	7.3E-06	0.00212	3.2E-06	0.00094	1.5E-05	0.0044	1.4E-05	0.00416	1.5E-05	0.00447	1.5E-05	0.00425
1,2,4,5-Tetrachlorobenzene-	no CSF	no RfD														
1,2-Dichlorobenzene	no CSF	0.25688	no CSF	0.37579	no CSF	0.19182	no CSF	0.15239	no CSF	0.44296	no CSF	0.44293	no CSF	0.44178	no CSF	0.44176
1,2-Dichloroethane	0.02924	7.52621	0.02924	7.52621	0.02924	7.52621	0.02924	7.52621	0.03391	8.72912	0.03391	8.72912	0.03357	8.64023	0.03357	8.64023
1,2-Dichloropropane	0.0009	2.8942	0.0009	2.8942	0.0009	2.8942	0.0009	2.8942	0.00109	3.50012	0.00109	3.50012	0.00108	3.46057	0.00108	3.46057
1,2-Diphenylhydrazine	9.7E-06	no RfD	1E-05	no RfD												
1,2-Trans-Dichloroethylene	no CSF	0.57044	no CSF	0.71233	no CSF	0.71233	no CSF	0.70401	no CSF	0.70401						
1,3-Dichlorobenzene	no CSF	0.00145	no CSF	0.00225	no CSF	0.001	no CSF	0.00072	no CSF	0.00239						
1,3-Dichloropropene	0.00022	0.67075	0.00022	0.67075	0.00022	0.67075	0.00022	0.67075	0.00027	0.83763	0.00027	0.83763	0.00027	0.82785	0.00027	0.82785
1,4-Dichlorobenzene	no CSF	0.05887	no CSF	0.08666	no CSF	0.04362	no CSF	0.03431	no CSF	0.10119	no CSF	0.10118	no CSF	0.10094	no CSF	0.10093
2,4,5-Trichlorophenol-	no CSF	no RfD														
2,4,6-Trichlorophenol	0.00018	0.00197	0.0002	0.00224	0.00017	0.00189	0.00017	0.00186	0.00022	0.0024	0.00022	0.0024	0.00022	0.0024	0.00022	0.0024
2,4-Dichlorophenol	no CSF	0.01587	no CSF	0.01599	no CSF	0.01586	no CSF	0.01586	no CSF	0.01791	no CSF	0.01791	no CSF	0.0178	no CSF	0.0178

Nitrobenzene	no CSF	0.78251	no CSF	0.75415	no CSF	0.75415	no CSF	0.74823	no CSF	0.74823						
2,4-Dinitrophenol	no CSF	0.51256	no CSF	0.45007	no CSF	0.45007	no CSF	0.44717	no CSF	0.44717						
2,4-Dinitrotoluene	8.1E-05	0.10867	8.1E-05	0.10867	8.1E-05	0.10867	8.1E-05	0.10867	8.4E-05	0.11245	8.4E-05	0.11245	8.4E-05	0.11142	8.4E-05	0.11142
2-Chloronaphthalene	no CSF	0.03522	no CSF	0.06614	no CSF	0.01851	no CSF	0.00866	no CSF	0.04137	no CSF	0.04004	no CSF	0.04189	no CSF	0.04067
2-Chlorophenol	no CSF	0.1429	no CSF	0.16058	no CSF	0.16058	no CSF	0.15894	no CSF	0.15894						
2-Methyl-4,6-Dinitrophenol	no CSF	0.04763	no CSF	0.0401	no CSF	0.0401	no CSF	0.03987	no CSF	0.03987						
3,3'-Dichlorobenzidine	2.8E-06	no RfD	3.6E-06	no RfD	2.4E-06	no RfD	2.3E-06	no RfD	4.1E-06	no RfD						
3-Methyl-4-Chlorophenol	no CSF	0.78584	no CSF	0.78641	no CSF	0.78583	no CSF	0.78583	no CSF	0.78652	no CSF	0.78652	no CSF	0.78208	no CSF	0.78208
4,4'-DDD	1.9E-06	0.00023	4.4E-06	0.00053	6.9E-07	8.3E-05	1.8E-07	2.1E-05	7E-07	8.4E-05	2.8E-07	3.3E-05	7.3E-07	8.7E-05	3E-07	3.6E-05
4,4'-DDE	5.1E-06	0.00043	1.2E-05	0.00102	1.8E-06	0.00015	4.6E-07	3.9E-05	1.8E-06	0.00015	6.7E-07	5.6E-05	1.9E-06	0.00016	7.2E-07	6.1E-05
4,4'-DDT	5.2E-06	0.00089	1.2E-05	0.00212	1.9E-06	0.00032	4.8E-07	8.1E-05	1.9E-06	0.00032	6.9E-07	0.00012	1.9E-06	0.00033	7.5E-07	0.00013

Table A3: Site and species-specific Risk Based Concentrations and Risk Quotients for carcinogenic risk (CSF based) for Chinook Salmon. Risk Quotients based on US EPA and Idaho Human Health Water Quality Guidelines (water + organism). Highlighted cells indicate a RQ greater than 10.

Chemical Name	Chinook (both sexes)											
	Bonneville Dam to Lower Granite Dam			Astoria to Lewiston			Astoria to Hells Canyon Dam			Astoria to Upper Salmon River		
	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}
Acenaphthene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Acrolein	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Acrylonitrile	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Aldrin	4.98135E-08	0.015457664	0.98366955	1.18486E-07	0.006499	0.413552	1.81459E-08	0.042434	2.700332	4.60984E-09	0.167034	10.62944
alpha-BHC	5.16754E-08	6.966559632	50.3140418	1.09979E-07	3.273361	23.64094	2.24115E-08	16.06316	116.0117	7.61754E-09	47.25936	341.3176
alpha-Endosulfan	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Anthracene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Benzene	0.001244456	0.466067023	1.76784043	0.001244472	0.466061	1.767818	0.001244456	0.466067	1.76784	0.001244456	0.466067	1.76784
Benzidine	5.57332E-07	0.251196725	0.15430656	5.57332E-07	0.251197	0.154307	5.57332E-07	0.251197	0.154307	5.57332E-07	0.251197	0.154307
Benzo(a) Anthracene	8.20694E-07	1.462177373	4.63022835	1.56817E-06	0.765223	2.423205	4.20278E-07	2.855256	9.041643	1.88448E-07	6.367789	20.16467
Benzo(a) Pyrene	3.15873E-07	0.379899972	12.0301658	4.15736E-07	0.288645	9.140419	2.66469E-07	0.450334	14.26056	2.42215E-07	0.495427	15.68851
Benzo(b) Fluoranthene	8.90871E-07	1.346995926	4.2654871	1.65597E-06	0.724652	2.29473	4.7565E-07	2.522865	7.989073	2.28444E-07	5.252932	16.63428
Benzo(k) Fluoranthene	1.07406E-05	1.117254372	0.35379722	2.09761E-05	0.57208	0.181159	5.32011E-06	2.255593	0.714271	2.25737E-06	5.315915	1.683373
beta-BHC	1.80864E-07	44.23212465	50.3140418	3.84925E-07	20.78325	23.64094	7.84404E-08	101.9883	116.0117	2.66614E-08	300.0594	341.3176
beta-Endosulfan	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Bis(Chloromethyl) Ether	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Bis(2-Chloroethyl) Ether	0.000139903	0.214434463	0.21443446	0.000139903	0.214434	0.214434	0.000139903	0.214434	0.214434	0.000139903	0.214434	0.214434
** Bis(2-Chloro-1-Methylethyl) Ether	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Bis(2-Ethylhexyl) Phthalate	0.003746365	0.085416134	0.3203105	0.004411992	0.07253	0.271986	0.003492268	0.091631	0.343616	0.003415513	0.09369	0.351338
Bromoform	0.005253078	1.332552089	0.81856771	0.005253078	1.332552	0.818568	0.005253078	1.332552	0.818568	0.005253078	1.332552	0.818568
Butylbenzyl Phthalate	0.025879076	0.003864126	57.9618837	0.025879076	0.003864	57.96188	0.025879076	0.003864	57.96188	0.025879076	0.003864	57.96188
Carbon Tetrachloride	5.97719E-05	6.692113177	3.84796508	6.12194E-05	6.533879	3.75698	5.96132E-05	6.709924	3.858206	5.9606E-05	6.710729	3.858669

Hexachloroethane	1.01944E-05	9.809342916	137.330801	1.97561E-05	5.061731	70.86424	5.1095E-06	19.57137	273.9992	2.21092E-06	45.23006	633.2209
Indeno(1,2,3-cd)Pyrene	5.64291E-06	0.212656286	0.67341157	8.18845E-06	0.146548	0.464068	4.25636E-06	0.281931	0.892781	3.42431E-06	0.350435	1.109711
Isophorone	0.079396638	0.428229721	0.44082471	0.079396638	0.42823	0.440825	0.079396638	0.42823	0.440825	0.079396638	0.42823	0.440825
Methoxychlor	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Methyl Bromide	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Methylene Chloride	0.078591913	0.254479108	0.05853019	0.078591913	0.254479	0.05853	0.078591913	0.254479	0.05853	0.078591913	0.254479	0.05853
Nitrobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Pentachlorobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Pentachlorophenol	1.39531E-06	21.50058067	193.505226	2.46059E-06	12.19222	109.73	8.05731E-07	37.23328	335.0995	4.39427E-07	68.27079	614.4371
Phenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Pyrene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Tetrachloroethylene	0.000430309	23.23908799	1.60349707	0.000618022	16.18064	1.116464	0.000328718	30.42125	2.099066	0.000268593	37.23112	2.568947
Toluene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Toxaphene	3.32438E-07	2.105658671	0.84226347	7.8633E-07	0.890212	0.356085	1.22169E-07	5.729772	2.291909	3.14929E-08	22.22724	8.890894
Trichloroethylene	0.000204935	2.927756801	12.1989867	0.000205035	2.926325	12.19302	0.000204934	2.92777	12.19904	0.000204934	2.92777	12.19904
Vinyl Chloride	4.78729E-05	0.459549856	0.52221575	4.78729E-05	0.45955	0.522216	4.78729E-05	0.45955	0.522216	4.78729E-05	0.45955	0.522216
1,1,1-Trichloroethane	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,1,2,2-Tetrachloroethane	6.15211E-05	3.250915428	2.76327811	6.15288E-05	3.250511	2.762934	6.15211E-05	3.250917	2.763279	6.15211E-05	3.250917	2.763279
1,1,2-Trichloroethane	0.000668646	0.822557811	0.8823802	0.000668646	0.822558	0.88238	0.000668646	0.822558	0.88238	0.000668646	0.822558	0.88238
1,1-Dichloroethylene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,2,4-Trichlorobenzene	1.43941E-05	4.932586934	2431.55694	2.76213E-05	2.570479	1267.138	7.32364E-06	9.694631	4779.043	3.24887E-06	21.85374	10772.97
1,2,4,5-Tetrachlorobenzene-	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,2-Dichlorobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,2-Dichloroethane	0.029239345	0.338584877	0.01299619	0.029239345	0.338585	0.012996	0.029239345	0.338585	0.012996	0.029239345	0.338585	0.012996
1,2-Dichloropropane	0.000900274	0.999695551	0.55538642	0.000900274	0.999696	0.555386	0.000900274	0.999696	0.555386	0.000900274	0.999696	0.555386
1,2-Diphenylhydrazine	9.6729E-06	3.101449455	3.72173935	9.68239E-06	3.098407	3.718089	9.67276E-06	3.101492	3.72179	9.67276E-06	3.101492	3.721791
1,2-Trans-Dichloroethylene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,3-Dichlorobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,3-Dichloropropene	0.000219918	1.227731698	1.54603251	0.000219918	1.227731	1.546032	0.000219918	1.227732	1.546033	0.000219918	1.227732	1.546033

1,4-Dichlorobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2,4,5-Trichlorophenol-	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2,4,6-Trichlorophenol	0.000179254	8.36802248	7.81015431	0.000203361	7.376034	6.884298	0.000171371	8.752942	8.169413	0.000169543	8.847319	8.257497	
2,4-Dichlorophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Nitrobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2,4-Dinitrophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2,4-Dinitrotoluene	8.14617E-05	0.601509789	1.3503281	8.14617E-05	0.60151	1.350328	8.14617E-05	0.60151	1.350328	8.14617E-05	0.60151	1.350328	
2-Chloronaphthalene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2-Chlorophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2-Methyl-4,6-Dinitrophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
3,3'-Dichlorobenzidine	2.79842E-06	17.50985925	7.50422539	3.5922E-06	13.64068	5.846006	2.42131E-06	20.23699	8.672997	2.25049E-06	21.77306	9.331313	
3-Methyl-4-Chlorophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
4,4'-DDD	1.8811E-06	0.063792333	0.16479686	4.44818E-06	0.026977	0.069691	6.91609E-07	0.173508	0.44823	1.78419E-07	0.672575	1.737484	
4,4'-DDE	5.1019E-06	0.0035281	0.04312122	1.2189E-05	0.001477	0.018049	1.84563E-06	0.009753	0.1192	4.63487E-07	0.038836	0.474663	
4,4'-DDT	5.22682E-06	0.005739626	0.05930946	1.24696E-05	0.002406	0.02486	1.89508E-06	0.01583	0.163581	4.77689E-07	0.062802	0.648958	

Table A4: Site and species-specific Risk Based Concentrations and Risk Quotients for carcinogenic risk (CSF based) for Sockeye Salmon. Risk Quotients based on US EPA and Idaho Human Health Water Quality Guidelines (water + organism). Highlighted cells indicate a RQ greater than 10.

Chemical Name	Sockeye Males						Sockeye Females					
	Astoria to Wenatchee River			Astoria to Redfish Lake			Astoria to Wenatchee River			Astoria to Redfish Lake		
	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}
Acenaphthene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Acrolein	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Acrylonitrile	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Aldrin	1.80177E-08	0.042736	2.719548	6.85471E-09	0.112332	7.148374	1.86723E-08	0.041238	2.624214	7.43228E-09	0.103602	6.592862
alpha-BHC	3.96071E-08	9.089271	65.64473	3.12143E-08	11.53318	83.2952	4.05291E-08	8.882502	64.1514	3.25071E-08	11.07451	79.98259
alpha-Endosulfan	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Anthracene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Benzene	0.001655257	0.350399	1.329099	0.001655257	0.350399	1.329099	0.001634869	0.354768	1.345673	0.001634869	0.354768	1.345673
Benzidine	6.37348E-07	0.21966	0.134934	6.37348E-07	0.21966	0.134934	6.31252E-07	0.221781	0.136237	6.31252E-07	0.221781	0.136237
Benzo(a) Anthracene	6.69084E-07	1.793496	5.679405	5.96517E-07	2.011678	6.370313	6.86454E-07	1.748114	5.535696	6.19123E-07	1.938225	6.137712
Benzo(a) Pyrene	3.67761E-07	0.326299	10.3328	3.67715E-07	0.32634	10.3341	3.70152E-07	0.324191	10.26606	3.70113E-07	0.324225	10.26713
Benzo(b) Fluoranthene	7.75426E-07	1.547536	4.900532	7.15891E-07	1.676233	5.308071	7.94109E-07	1.511127	4.785236	7.39431E-07	1.622869	5.139087
Benzo(k) Fluoranthene	8.23942E-06	1.456413	0.461197	7.07745E-06	1.695527	0.536917	8.46635E-06	1.417376	0.448836	7.37889E-06	1.62626	0.514982
beta-BHC	1.38625E-07	57.70966	65.64473	1.0925E-07	73.22655	83.2952	1.41852E-07	56.39684	64.1514	1.13775E-07	70.31436	79.98259
beta-Endosulfan	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Bis(Chloromethyl) Ether	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Bis(2-Chloroethyl) Ether	0.000155018	0.193526	0.193526	0.000155018	0.193526	0.193526	0.00015362	0.195288	0.195288	0.00015362	0.195288	0.195288
** Bis(2-Chloro-1-Methylethyl) Ether	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Bis(2-Ethylhexyl) Phthalate	0.004166861	0.076796	0.287987	0.004166846	0.076797	0.287988	0.004181276	0.076532	0.286994	0.004181264	0.076532	0.286995
Bromoform	0.005411407	1.293564	0.794618	0.005411407	1.293564	0.794618	0.005364735	1.304818	0.801531	0.005364735	1.304818	0.801531
Butylbenzyl Phthalate	0.020486288	0.004881	73.21971	0.020486288	0.004881	73.21971	0.020406742	0.0049	73.50512	0.020406742	0.0049	73.50512
Carbon Tetrachloride	8.46715E-05	4.724141	2.716381	8.46715E-05	4.724141	2.716381	8.38508E-05	4.770376	2.742966	8.38508E-05	4.770376	2.742966

Hexachloroethane	9.90653E-06	10.09435	141.3209	9.1627E-06	10.91381	152.7933	1.00936E-05	9.907259	138.7016	9.40445E-06	10.63326	148.8657
Indeno(1,2,3-cd)Pyrene	6.53429E-06	0.183647	0.581548	6.52619E-06	0.183874	0.582269	6.59987E-06	0.181822	0.575769	6.59297E-06	0.182012	0.576372
Isophorone	0.087463313	0.388734	0.400168	0.087463313	0.388734	0.400168	0.086594006	0.392637	0.404185	0.086594006	0.392637	0.404185
Methoxychlor	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Methyl Bromide	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Methylene Chloride	0.088182363	0.226803	0.052165	0.088182363	0.226803	0.052165	0.087389609	0.22886	0.052638	0.087389609	0.22886	0.052638
Nitrobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Pentachlorobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Pentachlorophenol	1.36712E-06	21.94386	197.4948	1.31885E-06	22.74711	204.724	1.39441E-06	21.51454	193.6309	1.35086E-06	22.20802	199.8722
Phenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Pyrene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Tetrachloroethylene	0.000748558	13.35901	0.921772	0.000748534	13.35944	0.921801	0.000746097	13.40309	0.924813	0.000746076	13.40346	0.924839
Toluene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Toxaphene	1.24315E-07	5.630852	2.252341	4.92944E-08	14.2004	5.680162	1.28798E-07	5.434888	2.173955	5.33924E-08	13.11049	5.244194
Trichloroethylene	0.000274315	2.187263	9.113596	0.000274315	2.187263	9.113596	0.000271121	2.213032	9.220967	0.000271121	2.213032	9.220967
Vinyl Chloride	5.62263E-05	0.391276	0.444632	5.62263E-05	0.391276	0.444632	5.5627E-05	0.395491	0.449422	5.5627E-05	0.395491	0.449422
1,1,1-Trichloroethane	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,1,2,2-Tetrachloroethane	7.83336E-05	2.553184	2.170206	7.83336E-05	2.553184	2.170206	7.74546E-05	2.582159	2.194835	7.74546E-05	2.582159	2.194835
1,1,2-Trichloroethane	0.000814453	0.6753	0.724413	0.000814453	0.6753	0.724413	0.000805172	0.683084	0.732763	0.000805172	0.683084	0.732763
1,1-Dichloroethylene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,2,4-Trichlorobenzene	1.5171E-05	4.679992	2307.038	1.43338E-05	4.95333	2441.783	1.54159E-05	4.605642	2270.387	1.46434E-05	4.848613	2390.161
1,2,4,5-Tetrachlorobenzene-	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,2-Dichlorobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,2-Dichloroethane	0.03391268	0.291926	0.011205	0.03391268	0.291926	0.011205	0.033567342	0.29493	0.011321	0.033567342	0.29493	0.011321
1,2-Dichloropropane	0.001088752	0.826635	0.459241	0.001088752	0.826635	0.459241	0.001076449	0.836083	0.46449	0.001076449	0.836083	0.46449
1,2-Diphenylhydrazine	1.03137E-05	2.908753	3.490503	1.03137E-05	2.908753	3.490503	1.02423E-05	2.929017	3.51482	1.02423E-05	2.929017	3.51482
1,2-Trans-Dichloroethylene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,3-Dichlorobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
1,3-Dichloropropene	0.000274633	0.983132	1.238018	0.000274633	0.983132	1.238018	0.000271426	0.994746	1.252644	0.000271426	0.994746	1.252644

1,4-Dichlorobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2,4,5-Trichlorophenol-	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2,4,6-Trichlorophenol	0.00021861	6.861527	6.404092	0.00021861	6.861527	6.404092	0.000218382	6.868689	6.410777	0.000218382	6.86869	6.410777
2,4-Dichlorophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
Nitrobenzene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2,4-Dinitrophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2,4-Dinitrotoluene	8.42975E-05	0.581274	1.304902	8.42975E-05	0.581274	1.304902	8.35251E-05	0.58665	1.31697	8.35251E-05	0.58665	1.31697
2-Chloronaphthalene	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2-Chlorophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
2-Methyl-4,6-Dinitrophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
3,3'-Dichlorobenzidine	4.14198E-06	11.8301	5.070044	4.14196E-06	11.83015	5.070065	4.13405E-06	11.85279	5.079769	4.13403E-06	11.85284	5.079787
3-Methyl-4-Chlorophenol	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF	no CSF
4,4'-DDD	7.01859E-07	0.170975	0.441684	2.77917E-07	0.431784	1.115443	7.27234E-07	0.165009	0.426272	3.0108E-07	0.398565	1.029627
4,4'-DDE	1.80684E-06	0.009962	0.12176	6.68201E-07	0.026938	0.329242	1.87257E-06	0.009612	0.117485	7.24826E-07	0.024834	0.303521
4,4'-DDT	1.86198E-06	0.016112	0.166489	6.94352E-07	0.043206	0.44646	1.92974E-06	0.015546	0.160643	7.53132E-07	0.039834	0.411615

Table A5: Site and species-specific Risk Based Concentrations and Risk Quotients for non-carcinogenic risk (RfD-based) for Chinook Salmon. Risk Quotients based on US EPA and Idaho Human Health Water Quality Guidelines (water + organism). Highlighted cells indicate a RQ greater than 10.

Chemical Name	Chinook (both sexes)											
	Bonneville Dam to Lower Granite Dam			Astoria to Lewiston			Astoria to Hells Canyon Dam			Astoria to Upper Salmon River		
	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}
Acenaphthene	0.369538524	0.189425447	1.81307214	0.370491866	0.188938	1.808407	0.36951395	0.189438	1.813193	0.369513801	0.189438	1.813193
Acrolein	1.280838497	0.002342216	0.14834033	1.280838497	0.002342	0.14834	1.280838497	0.002342	0.14834	1.280838497	0.002342	0.14834
Acrylonitrile	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Aldrin	2.54049E-05	3.03091E-05	0.00192876	6.04277E-05	1.27E-05	0.000811	9.25442E-06	8.32E-05	0.005295	2.35102E-06	0.000328	0.020842
alpha-BHC	0.002604442	0.000138225	0.00099829	0.005542926	6.49E-05	0.000469	0.001129541	0.000319	0.002302	0.000383924	0.000938	0.006772
alpha-Endosulfan	0.002830705	7.065377259	21.9026695	0.00517146	3.86738	11.98888	0.001551123	12.89388	39.97103	0.000777271	25.73104	79.76623
Anthracene	0.151567724	1.979313222	54.7609991	0.270144917	1.110515	30.72425	0.086160772	3.481863	96.33154	0.045821348	6.547167	181.1383
Benzene	0.009333422	0.06214227	0.23571206	0.009333539	0.062141	0.235709	0.009333421	0.062142	0.235712	0.009333421	0.062142	0.235712
Benzidine	0.384559153	3.64053E-07	2.2363E-07	0.384559153	3.64E-07	2.24E-07	0.384559153	3.64E-07	2.24E-07	0.384559153	3.64E-07	2.24E-07
Benzo(a) Anthracene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Benzo(a) Pyrene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Benzo(b) Fluoranthene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Benzo(k) Fluoranthene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
beta-BHC	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
beta-Endosulfan	0.002830705	7.065377259	21.9026695	0.00517146	3.86738	11.98888	0.001551123	12.89388	39.97103	0.000777271	25.73104	79.76623
Bis(Chloromethyl) Ether	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Bis(2-Chloroethyl) Ether	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
** Bis(2-Chloro-1-Methylethyl) Ether	0.481482558	0.415383686	2.9076858	0.481529525	0.415343	2.907402	0.481482403	0.415384	2.907687	0.481482403	0.415384	2.907687
Bis(2-Ethylhexyl) Phthalate	3.146946444	0.000101686	0.00038132	3.706073031	8.63E-05	0.000324	2.933505071	0.000109	0.000409	2.869030922	0.000112	0.000418
Bromoform	0.709165524	0.009870756	0.00606346	0.709165544	0.009871	0.006063	0.709165524	0.009871	0.006063	0.709165524	0.009871	0.006063
Butylbenzyl Phthalate	63.92131806	1.56442E-06	0.02346635	63.92131806	1.56E-06	0.023466	63.92131806	1.56E-06	0.023466	63.92131806	1.56E-06	0.023466
Carbon Tetrachloride	0.016736119	0.023900404	0.01374273	0.017141425	0.023335	0.013418	0.016691694	0.023964	0.013779	0.016689693	0.023967	0.013781

Chlordane	0.000279953	0.001107331	0.00285763	0.000666749	0.000465	0.0012	0.000101774	0.003046	0.007861	2.57679E-05	0.01203	0.031046
Chlorobenzene	0.121991793	0.819727273	1.06564545	0.122564852	0.815895	1.060663	0.121970136	0.819873	1.065835	0.121969915	0.819874	1.065837
Chlorodibromomethane	0.578222365	0.001383551	0.00069178	0.578222374	0.001384	0.000692	0.578222365	0.001384	0.000692	0.578222365	0.001384	0.000692
Chloroform	0.317687707	0.188864721	0.01794215	0.317687731	0.188865	0.017942	0.317687707	0.188865	0.017942	0.317687707	0.188865	0.017942
Chlorophenoxy Herbicide (2,4-D)	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Chlorophenoxy Herbicide (2,4,5-TP)	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Chrysene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Cyanide	7.700529371	0.000519445	0.01818057	7.700529371	0.000519	0.018181	7.700529371	0.000519	0.018181	7.700529371	0.000519	0.018181
Dibenzo(a,h)Anthracene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Dichlorobromomethane	0.101267847	0.009381063	0.00543114	0.101267848	0.009381	0.005431	0.101267847	0.009381	0.005431	0.101267847	0.009381	0.005431
Dieeldrin	1.40465E-05	8.54303E-05	0.00370198	3.31969E-05	3.61E-05	0.001566	5.16888E-06	0.000232	0.01006	1.33538E-06	0.000899	0.03894
Diethyl Phthalate	98.31212211	0.006103011	0.17291866	98.31212211	0.006103	0.172919	98.31212211	0.006103	0.172919	98.31212211	0.006103	0.172919
Dimethyl Phthalate	5129.947768	0.000389868	0.05263211	5129.947768	0.00039	0.052632	5129.947768	0.00039	0.052632	5129.947768	0.00039	0.052632
Di-n-Butyl Phthalate	1.850809791	0.010806081	1.08060807	1.850809831	0.010806	1.080608	1.850809791	0.010806	1.080608	1.850809791	0.010806	1.080608
Dinitrophenols	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Endosulfan Sulfate	0.00351635	5.687716562	17.6319213	0.005904401	3.387304	10.50064	0.002180139	9.173726	28.43855	0.00132972	15.04077	46.62637
Endrin	8.42792E-05	0.355959548	0.70005378	0.000199182	0.150616	0.296212	3.10133E-05	0.967328	1.902411	8.01231E-06	3.744241	7.363673
Endrin Aldehyde	8.33197E-05	12.00196151	3.48056884	0.000192292	5.200411	1.508119	3.18279E-05	31.41902	9.111517	8.75055E-06	114.2785	33.14076
Ethylbenzene	0.128156853	0.530599794	4.13555722	0.128727619	0.528247	4.117221	0.128136008	0.530686	4.13623	0.128135804	0.530687	4.136237
Fluoranthene	0.020447604	0.978109699	6.35771304	0.037482542	0.533582	3.468281	0.011148024	1.79404	11.66126	0.005540446	3.609818	23.46381
Fluorene	0.033352089	1.499156474	32.9814424	0.048982732	1.020768	22.45689	0.024781952	2.017597	44.38714	0.019565217	2.555556	56.22222
gamma-BHC (Lindane)	0.00153011	2.744901352	0.64047698	0.003256469	1.289741	0.300939	0.000663605	6.329062	1.476781	0.000225555	18.62071	4.344832
Heptachlor	3.10264E-05	0.000190161	0.00254622	7.30145E-05	8.08E-05	0.001082	1.1494E-05	0.000513	0.006873	3.00281E-06	0.001965	0.026309
Heptachlor Epoxide	3.65436E-06	0.008756662	0.01067218	8.4736E-06	0.003776	0.004603	1.38567E-06	0.023094	0.028145	3.76302E-07	0.085038	0.10364
Hexachlorobenzene	0.000297798	0.000265281	0.00094023	0.000688627	0.000115	0.000407	0.000113409	0.000697	0.002469	3.10209E-05	0.002547	0.009026
Hexachlorobutadiene	8.46148E-05	0.118182692	5.20003843	0.000193831	0.051591	2.270015	3.27035E-05	0.305778	13.45421	9.16865E-06	1.090673	47.9896
Hexachlorocyclo-hexane-Technical	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Hexachlorocyclopentadiene	0.001805417	2.215555147	22.1555515	0.004083838	0.979471	9.794708	0.00071178	5.619717	56.19717	0.000206271	19.39198	193.9198

Hexachloroethane	0.000285442	0.350333676	4.90467146	0.00055317	0.180776	2.530866	0.000143066	0.698978	9.785687	6.19057E-05	1.615359	22.61503
Indeno(1,2,3-cd)Pyrene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Isophorone	15.08536117	0.002253841	0.00232013	15.08536117	0.002254	0.00232	15.08536117	0.002254	0.00232	15.08536117	0.002254	0.00232
Methoxychlor	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Methyl Bromide	4.327535316	0.023107841	0.01086069	4.327535316	0.023108	0.010861	4.327535316	0.023108	0.010861	4.327535316	0.023108	0.010861
Methylene Chloride	0.943102958	0.021206592	0.00487752	0.943102958	0.021207	0.004878	0.943102958	0.021207	0.004878	0.943102958	0.021207	0.004878
Nitrobenzene	0.140000177	0.071428481	0.12142842	0.140000177	0.071428	0.121428	0.140000177	0.071428	0.121428	0.140000177	0.071428	0.121428
Pentachlorobenzene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Pentachlorophenol	0.002790622	0.01075029	0.09675261	0.00492117	0.006096	0.054865	0.001611462	0.018617	0.16755	0.000878853	0.034135	0.307219
Phenol	172.1602415	0.023234168	0.12197938	172.1602415	0.023234	0.121979	172.1602415	0.023234	0.121979	172.1602415	0.023234	0.121979
Pyrene	0.067348662	0.296962099	12.3239271	0.07487413	0.267115	11.08527	0.065143504	0.307014	12.7411	0.064716066	0.309042	12.82525
Tetrachloroethylene	0.0054219	1.844372063	0.12726167	0.007787083	1.284178	0.088608	0.004141842	2.414385	0.166593	0.003384266	2.954851	0.203885
Toluene	0.100851774	0.565185894	12.8902046	0.10086676	0.565102	12.88829	0.10085171	0.565186	12.89021	0.100851709	0.565186	12.89021
Toxaphene	0.000127988	0.005469243	0.0021877	0.000302737	0.002312	0.000925	4.7035E-05	0.014883	0.005953	1.21248E-05	0.057733	0.023093
Trichloroethylene	0.005123376	0.117110272	0.48795947	0.005125883	0.117053	0.487721	0.005123354	0.117111	0.487962	0.005123354	0.117111	0.487962
Vinyl Chloride	0.215428204	0.000102122	0.00011605	0.215428204	0.000102	0.000116	0.215428204	0.000102	0.000116	0.215428204	0.000102	0.000116
1,1,1-Trichloroethane	19.0223362	0.525697785	0	19.03467083	0.525357	0	19.02220321	0.525701	0	19.02220297	0.525701	0
1,1,2,2-Tetrachloroethane	0.246084531	0.000812729	0.00069082	0.246115159	0.000813	0.000691	0.246084414	0.000813	0.000691	0.246084414	0.000813	0.000691
1,1,2-Trichloroethane	0.152451291	0.00360771	0.00387009	0.152451293	0.003608	0.00387	0.152451291	0.003608	0.00387	0.152451291	0.003608	0.00387
1,1-Dichloroethylene	1.068659034	0.280725648	0.30879821	1.068661652	0.280725	0.308797	1.068659033	0.280726	0.308798	1.068659033	0.280726	0.308798
1,2,4-Trichlorobenzene	0.00417428	0.01700892	8.3846791	0.00801018	0.008864	4.36944	0.002123856	0.03343	16.47946	0.000942173	0.075358	37.14818
1,2,4,5-Tetrachlorobenzene-	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
1,2-Dichlorobenzene	0.256883677	3.892812551	1.63498127	0.375792433	2.661043	1.117638	0.191820416	5.213209	2.189548	0.152391462	6.562047	2.75606
1,2-Dichloroethane	7.526207375	0.001315404	5.049E-05	7.526207375	0.001315	5.05E-05	7.526207375	0.001315	5.05E-05	7.526207375	0.001315	5.05E-05
1,2-Dichloropropane	2.894201137	0.000310967	0.00017276	2.894201267	0.000311	0.000173	2.894201137	0.000311	0.000173	2.894201137	0.000311	0.000173
1,2-Diphenylhydrazine	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
1,2-Trans-Dichloroethylene	0.570440789	0.175303032	0.24542424	0.570440931	0.175303	0.245424	0.570440789	0.175303	0.245424	0.570440789	0.175303	0.245424
1,3-Dichlorobenzene	0.001447408	4.836232294	221.084905	0.002247006	3.115256	142.4117	0.001000572	6.995998	319.817	0.00071699	9.763032	446.31
1,3-Dichloropropene	0.670749156	0.000402535	0.0005069	0.670749418	0.000403	0.000507	0.670749156	0.000403	0.000507	0.670749156	0.000403	0.000507

1,4-Dichlorobenzene	0.058871406	5.09585247	1.07012902	0.086659444	3.461827	0.726984	0.043618075	6.877883	1.444355	0.034310107	8.743779	1.836194
2,4,5-Trichlorophenol-	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
2,4,6-Trichlorophenol	0.001971792	0.760729316	0.71001403	0.002236975	0.670549	0.625845	0.00188508	0.795722	0.742674	0.001864972	0.804302	0.750682
2,4-Dichlorophenol	0.015865752	0.630288442	4.853221	0.015987776	0.625478	4.816179	0.015859418	0.63054	4.855159	0.015859318	0.630544	4.85519
Nitrobenzene	0.782505217	0.127794675	0.02172509	0.782505217	0.127795	0.021725	0.782505217	0.127795	0.021725	0.782505217	0.127795	0.021725
2,4-Dinitrophenol	0.512556875	0.01951003	0.13461921	0.512556875	0.01951	0.134619	0.512556875	0.01951	0.134619	0.512556875	0.01951	0.134619
2,4-Dinitrotoluene	0.108669886	0.000450907	0.00101224	0.108669886	0.000451	0.001012	0.108669886	0.000451	0.001012	0.108669886	0.000451	0.001012
2-Chloronaphthalene	0.035216563	22.71658359	28.3957295	0.066143999	12.09482	15.11853	0.018510677	43.2183	54.02288	0.008664643	92.32925	115.4116
2-Chlorophenol	0.142896947	0.209941505	0.56684206	0.14289695	0.209941	0.566842	0.142896947	0.209942	0.566842	0.142896947	0.209942	0.566842
2-Methyl-4,6-Dinitrophenol	0.04762963	0.041990669	0.27293935	0.04762963	0.041991	0.272939	0.04762963	0.041991	0.272939	0.04762963	0.041991	0.272939
3,3'-Dichlorobenzidine	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
3-Methyl-4-Chlorophenol	0.785839635	0.63626213	0	0.786412275	0.635799	0	0.785832992	0.636268	0	0.785832978	0.636268	0
4,4'-DDD	0.000225732	0.000531603	0.00137331	0.000533781	0.000225	0.000581	8.29931E-05	0.001446	0.003735	2.14103E-05	0.005605	0.014479
4,4'-DDE	0.000426008	4.22527E-05	0.00051642	0.001017778	1.77E-05	0.000216	0.00015411	0.000117	0.001428	3.87012E-05	0.000465	0.005685
4,4'-DDT	0.00088856	3.37625E-05	0.00034888	0.00211983	1.42E-05	0.000146	0.000322164	9.31E-05	0.000962	8.12071E-05	0.000369	0.003817

Table A6: Site and species-specific Risk Based Concentrations and Risk Quotients for non-carcinogenic risk (RfD-based) for Sockeye Salmon. Risk Quotients based on US EPA and Idaho Human Health Water Quality Guidelines (water + organism). Highlighted cells indicate a RQ greater than 10.

Chemical Name	Sockeye Males						Sockeye Females					
	Astoria to Wenatchee River			Astoria to Redfish Lake			Astoria to Wenatchee River			Astoria to Redfish Lake		
	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}	RBC (mg/L)	RQ _{EPA}	RQ _{Idaho}
Acenaphthene	0.337704489	0.207282	1.983983	0.337704489	0.207282	1.983983	0.336895605	0.207779	1.988747	0.336895605	0.207779	1.988747
Acrolein	1.063881813	0.00282	0.178591	1.063881813	0.00282	0.178591	1.06117027	0.002827	0.179048	1.06117027	0.002827	0.179048
Acrylonitrile	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Aldrin	9.18903E-06	8.38E-05	0.005332	3.4959E-06	0.00022	0.014016	9.52285E-06	8.09E-05	0.005146	3.79046E-06	0.000203	0.012927
alpha-BHC	0.0019962	0.00018	0.001302	0.0015732	0.000229	0.001653	0.002042668	0.000176	0.001273	0.001638357	0.00022	0.001587
alpha-Endosulfan	0.003607804	5.543539	17.18497	0.003542133	5.646315	17.50358	0.003643479	5.489259	17.0167	0.003583644	5.580911	17.30082
Anthracene	0.155946708	1.923734	53.22331	0.150854496	1.988671	55.0199	0.158744986	1.889823	52.28512	0.154139644	1.946287	53.84728
Benzene	0.012414425	0.04672	0.177213	0.012414425	0.04672	0.177213	0.012261518	0.047302	0.179423	0.012261518	0.047302	0.179423
Benzidine	0.439770073	3.18E-07	1.96E-07	0.439770073	3.18E-07	1.96E-07	0.435564165	3.21E-07	1.97E-07	0.435564165	3.21E-07	1.97E-07
Benzo(a) Anthracene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Benzo(a) Pyrene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Benzo(b) Fluoranthene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Benzo(k) Fluoranthene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
beta-BHC	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
beta-Endosulfan	0.003607804	5.543539	17.18497	0.003542133	5.646315	17.50358	0.003643479	5.489259	17.0167	0.003583644	5.580911	17.30082
Bis(Chloromethyl) Ether	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Bis(2-Chloroethyl) Ether	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
** Bis(2-Chloro-1-Methylethyl) Ether	0.578667596	0.345622	2.419351	0.578667596	0.345622	2.419351	0.572721149	0.34921	2.444471	0.572721149	0.34921	2.444471
Bis(2-Ethylhexyl) Phthalate	3.500163088	9.14E-05	0.000343	3.500150905	9.14E-05	0.000343	3.512271676	9.11E-05	0.000342	3.512261989	9.11E-05	0.000342
Bromoform	0.730540006	0.009582	0.005886	0.730540006	0.009582	0.005886	0.724239159	0.009665	0.005937	0.724239159	0.009665	0.005937
Butylbenzyl Phthalate	50.60113039	1.98E-06	0.029644	50.60113039	1.98E-06	0.029644	50.40465255	1.98E-06	0.029759	50.40465255	1.98E-06	0.029759
Carbon Tetrachloride	0.023708016	0.016872	0.009701	0.023708016	0.016872	0.009701	0.023478234	0.017037	0.009796	0.023478234	0.017037	0.009796

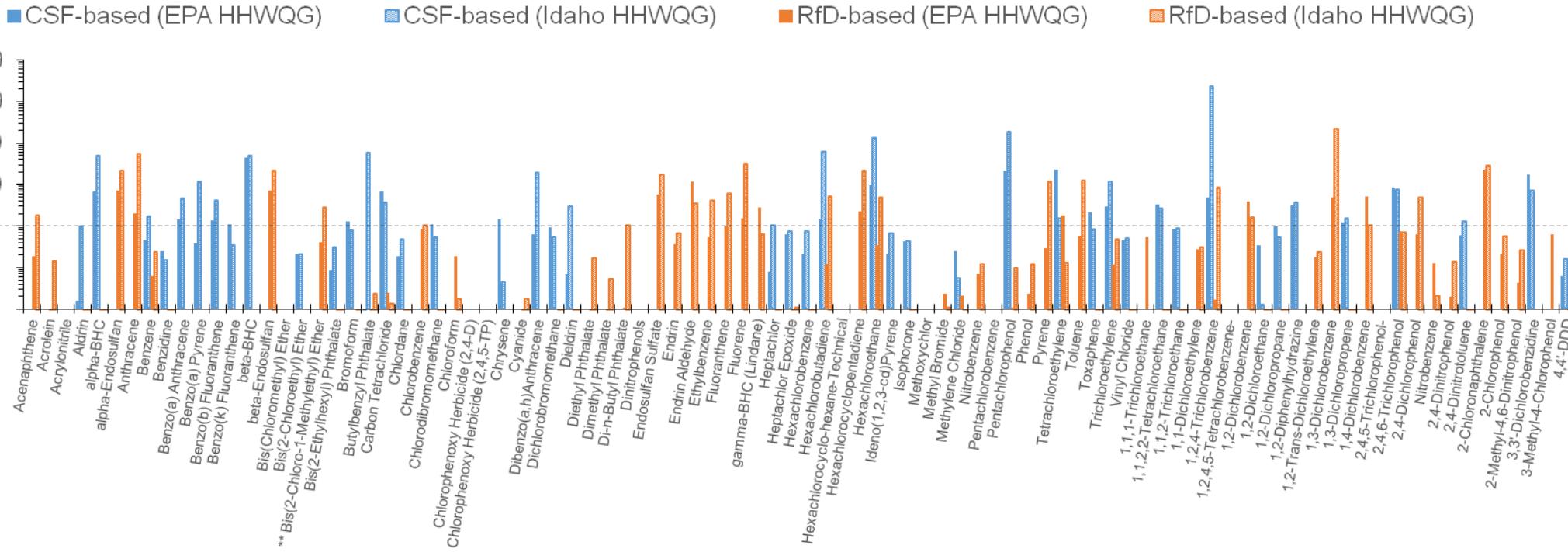
Chlordane	0.00010079	0.003076	0.007937	3.80818E-05	0.00814	0.021007	0.000104449	0.002968	0.007659	4.12923E-05	0.007507	0.019374
Chlorobenzene	0.147558191	0.677699	0.881008	0.147558191	0.677699	0.881008	0.146306774	0.683495	0.888544	0.146306774	0.683495	0.888544
Chlorodibromomethane	0.643482555	0.001243	0.000622	0.643482555	0.001243	0.000622	0.637001519	0.001256	0.000628	0.637001519	0.001256	0.000628
Chloroform	0.3898454	0.153907	0.014621	0.3898454	0.153907	0.014621	0.385367308	0.155696	0.014791	0.385367308	0.155696	0.014791
Chlorophenoxy Herbicide (2,4-D)	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Chlorophenoxy Herbicide (2,4,5-TP)	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Chrysene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Cyanide	6.083681179	0.000657	0.023012	6.083681179	0.000657	0.023012	6.061045031	0.00066	0.023098	6.061045031	0.00066	0.023098
Dibenzo(a,h)Anthracene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Dichlorobromomethane	0.119047222	0.00798	0.00462	0.119047222	0.00798	0.00462	0.117746122	0.008068	0.004671	0.117746122	0.008068	0.004671
Dieeldrin	5.39985E-06	0.000222	0.00963	2.19804E-06	0.000546	0.023657	5.59085E-06	0.000215	0.009301	2.37696E-06	0.000505	0.021877
Diethyl Phthalate	80.97372454	0.00741	0.209945	80.97372454	0.00741	0.209945	80.54866833	0.007449	0.211053	80.54866833	0.007449	0.211053
Dimethyl Phthalate	4281.496401	0.000467	0.063062	4281.496401	0.000467	0.063062	4257.731821	0.00047	0.063414	4257.731821	0.00047	0.063414
Di-n-Butyl Phthalate	1.511200273	0.013235	1.323451	1.511200273	0.013235	1.323451	1.50613352	0.013279	1.327904	1.50613352	0.013279	1.327904
Dinitrophenols	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Endosulfan Sulfate	0.005321816	3.758116	11.65016	0.005307465	3.768277	11.68166	0.005341197	3.744479	11.60788	0.005328309	3.753536	11.63596
Endrin	3.23991E-05	0.925952	1.821039	1.31883E-05	2.27475	4.473675	3.35451E-05	0.894318	1.758825	1.42617E-05	2.103531	4.136945
Endrin Aldehyde	3.73602E-05	26.76645	7.762272	1.8183E-05	54.99635	15.94894	3.86133E-05	25.8978	7.510362	1.95393E-05	51.17885	14.84187
Ethylbenzene	0.135693416	0.50113	3.905864	0.135693416	0.50113	3.905864	0.134934928	0.503947	3.927819	0.134934928	0.503947	3.927819
Fluoranthene	0.018607794	1.074818	6.98632	0.0174686	1.144911	7.441924	0.019027725	1.051098	6.832136	0.017986991	1.111915	7.227446
Fluorene	0.041954415	1.19177	26.21893	0.041917323	1.192824	26.24213	0.042260309	1.183143	26.02915	0.042228399	1.184037	26.04882
gamma-BHC (Lindane)	0.001172767	3.581273	0.83563	0.000924255	4.544201	1.060314	0.001200067	3.499804	0.816621	0.000962535	4.36348	1.018145
Heptachlor	1.1987E-05	0.000492	0.00659	4.94391E-06	0.001193	0.015979	1.24152E-05	0.000475	0.006363	5.3487E-06	0.001103	0.01477
Heptachlor Epoxide	1.56394E-06	0.020461	0.024937	7.25572E-07	0.044103	0.053751	1.61777E-06	0.01978	0.024107	7.81616E-07	0.040941	0.049897
Hexachlorobenzene	0.000123706	0.000639	0.002263	5.62713E-05	0.001404	0.004976	0.000128109	0.000617	0.002186	6.07661E-05	0.0013	0.004608
Hexachlorobutadiene	3.93192E-05	0.254329	11.19047	1.99806E-05	0.500486	22.02138	4.06265E-05	0.246145	10.83037	2.14406E-05	0.466406	20.52185
Hexachlorocyclo-hexane-Technical	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Hexachlorocyclopentadiene	0.000854787	4.67953	46.7953	0.000451371	8.861897	88.61897	0.000883808	4.525872	45.25872	0.00048451	8.255768	82.55768

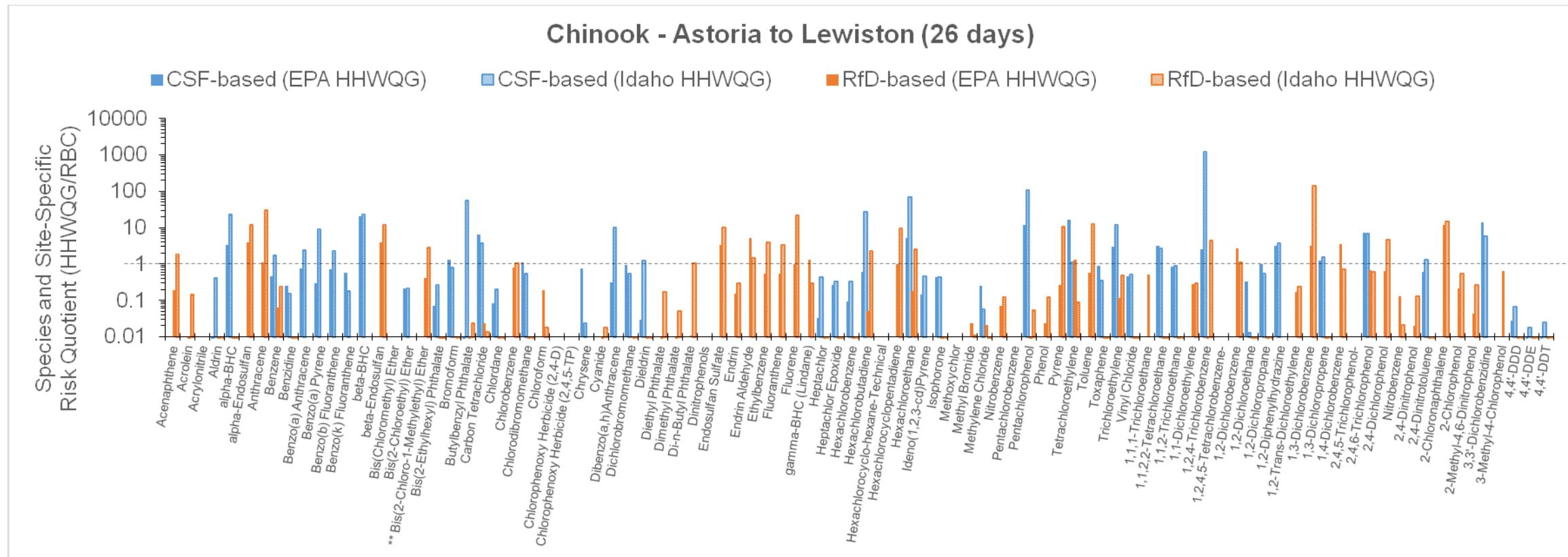
Hexachloroethane	0.000277383	0.360513	5.047175	0.000256556	0.389779	5.456904	0.000282621	0.353831	4.95363	0.000263325	0.379759	5.316631
Indeno(1,2,3-cd)Pyrene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Isophorone	16.61802939	0.002046	0.002106	16.61802939	0.002046	0.002106	16.4528612	0.002067	0.002127	16.4528612	0.002067	0.002127
Methoxychlor	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Methyl Bromide	4.549029225	0.021983	0.010332	4.549029225	0.021983	0.010332	4.512477545	0.022161	0.010416	4.512477545	0.022161	0.010416
Methylene Chloride	1.05818836	0.0189	0.004347	1.05818836	0.0189	0.004347	1.048675309	0.019072	0.004386	1.048675309	0.019072	0.004386
Nitrobenzene	0.145199266	0.068871	0.11708	0.145199266	0.068871	0.11708	0.14386484	0.06951	0.118166	0.14386484	0.06951	0.118166
Pentachlorobenzene	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
Pentachlorophenol	0.00273425	0.010972	0.098747	0.002637698	0.011374	0.102362	0.002788811	0.010757	0.096815	0.002701727	0.011104	0.099936
Phenol	156.7115225	0.025525	0.134004	156.7115225	0.025525	0.134004	155.6368908	0.025701	0.134929	155.6368908	0.025701	0.134929
Pyrene	0.072220055	0.276931	11.49265	0.072220041	0.276931	11.49265	0.072350938	0.27643	11.47186	0.072350927	0.27643	11.47186
Tetrachloroethylene	0.009431835	1.060239	0.073156	0.009431534	1.060273	0.073159	0.00940082	1.063737	0.073398	0.009400555	1.063767	0.0734
Toluene	0.109374486	0.521145	11.88577	0.109374486	0.521145	11.88577	0.108483227	0.525427	11.98342	0.108483227	0.525427	11.98342
Toxaphene	4.78613E-05	0.014626	0.00585	1.89783E-05	0.036884	0.014754	4.9587E-05	0.014117	0.005647	2.05561E-05	0.034053	0.013621
Trichloroethylene	0.006857886	0.087491	0.364544	0.006857886	0.087491	0.364544	0.006778031	0.088521	0.368839	0.006778031	0.088521	0.368839
Vinyl Chloride	0.253018143	8.7E-05	9.88E-05	0.253018143	8.7E-05	9.88E-05	0.250321525	8.79E-05	9.99E-05	0.250321525	8.79E-05	9.99E-05
1,1,1-Trichloroethane	24.81163124	0.403037	0	24.81163124	0.403037	0	24.53622355	0.407561	0	24.53622355	0.407561	0
1,1,2,2-Tetrachloroethane	0.313334259	0.000638	0.000543	0.313334259	0.000638	0.000543	0.309818242	0.000646	0.000549	0.309818242	0.000646	0.000549
1,1,2-Trichloroethane	0.185695251	0.002962	0.003177	0.185695251	0.002962	0.003177	0.183579231	0.002996	0.003214	0.183579231	0.002996	0.003214
1,1-Dichloroethylene	1.34655661	0.22279	0.24507	1.34655661	0.22279	0.24507	1.330819545	0.225425	0.247968	1.330819545	0.225425	0.247968
1,2,4-Trichlorobenzene	0.00439958	0.016138	7.955304	0.004156799	0.01708	8.41994	0.004470604	0.015882	7.82892	0.004246575	0.016719	8.241936
1,2,4,5-Tetrachlorobenzene-	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
1,2-Dichlorobenzene	0.44295515	2.257565	0.948177	0.442929211	2.257697	0.948233	0.441778294	2.263579	0.950703	0.441755349	2.263696	0.950752
1,2-Dichloroethane	8.729123836	0.001134	4.35E-05	8.729123836	0.001134	4.35E-05	8.640233781	0.001146	4.4E-05	8.640233781	0.001146	4.4E-05
1,2-Dichloropropane	3.500119757	0.000257	0.000143	3.500119757	0.000257	0.000143	3.460566935	0.00026	0.000144	3.460566935	0.00026	0.000144
1,2-Diphenylhydrazine	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
1,2-Trans-Dichloroethylene	0.712334168	0.140384	0.196537	0.712334168	0.140384	0.196537	0.704005508	0.142044	0.198862	0.704005508	0.142044	0.198862
1,3-Dichlorobenzene	0.002391841	2.926615	133.7881	0.002390988	2.92766	133.8359	0.002391177	2.927428	133.8253	0.002390418	2.928358	133.8678
1,3-Dichloropropene	0.837629364	0.000322	0.000406	0.837629364	0.000322	0.000406	0.827849181	0.000326	0.000411	0.827849181	0.000326	0.000411

1,4-Dichlorobenzene	0.101185582	2.964849	0.622618	0.101178355	2.965061	0.622663	0.10093891	2.972095	0.62414	0.100932514	2.972283	0.624179
2,4,5-Trichlorophenol-	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF
2,4,6-Trichlorophenol	0.002404713	0.623775	0.58219	0.002404712	0.623775	0.58219	0.002402205	0.624426	0.582798	0.002402205	0.624426	0.582798
2,4-Dichlorophenol	0.017913912	0.558225	4.298335	0.017913912	0.558225	4.298335	0.017797638	0.561872	4.326417	0.017797638	0.561872	4.326417
Nitrobenzene	0.754146544	0.1326	0.022542	0.754146544	0.1326	0.022542	0.748228957	0.133649	0.02272	0.748228957	0.133649	0.02272
2,4-Dinitrophenol	0.450073293	0.022219	0.153308	0.450073293	0.022219	0.153308	0.447166052	0.022363	0.154305	0.447166052	0.022363	0.154305
2,4-Dinitrotoluene	0.112452921	0.000436	0.000978	0.112452921	0.000436	0.000978	0.111422417	0.00044	0.000987	0.111422417	0.00044	0.000987
2-Chloronaphthalene	0.041373487	19.33605	24.17007	0.040035592	19.98222	24.97777	0.04189359	19.096	23.87	0.040666731	19.6721	24.59012
2-Chlorophenol	0.160581973	0.18682	0.504415	0.160581973	0.18682	0.504415	0.15894174	0.188748	0.509621	0.15894174	0.188748	0.509621
2-Methyl-4,6-Dinitrophenol	0.040097214	0.049879	0.324212	0.040097214	0.049879	0.324212	0.039866814	0.050167	0.326086	0.039866814	0.050167	0.326086
3,3'-Dichlorobenzidine	no RfD	no CSF	no CSF	no RfD	no CSF	no CSF	no RfD	no CSF	no RfD	no CSF	no CSF	no CSF
3-Methyl-4-Chlorophenol	0.786518495	0.635713	0	0.786518495	0.635713	0	0.782078589	0.639322	0	0.782078589	0.639322	0
4,4'-DDD	8.42231E-05	0.001425	0.003681	3.335E-05	0.003598	0.009295	8.72681E-05	0.001375	0.003552	3.61296E-05	0.003321	0.00858
4,4'-DDE	0.000150871	0.000119	0.001458	5.57948E-05	0.000323	0.003943	0.00015636	0.000115	0.001407	6.05229E-05	0.000297	0.003635
4,4'-DDT	0.000316537	9.48E-05	0.000979	0.00011804	0.000254	0.002626	0.000328057	9.14E-05	0.000945	0.000128032	0.000234	0.002421

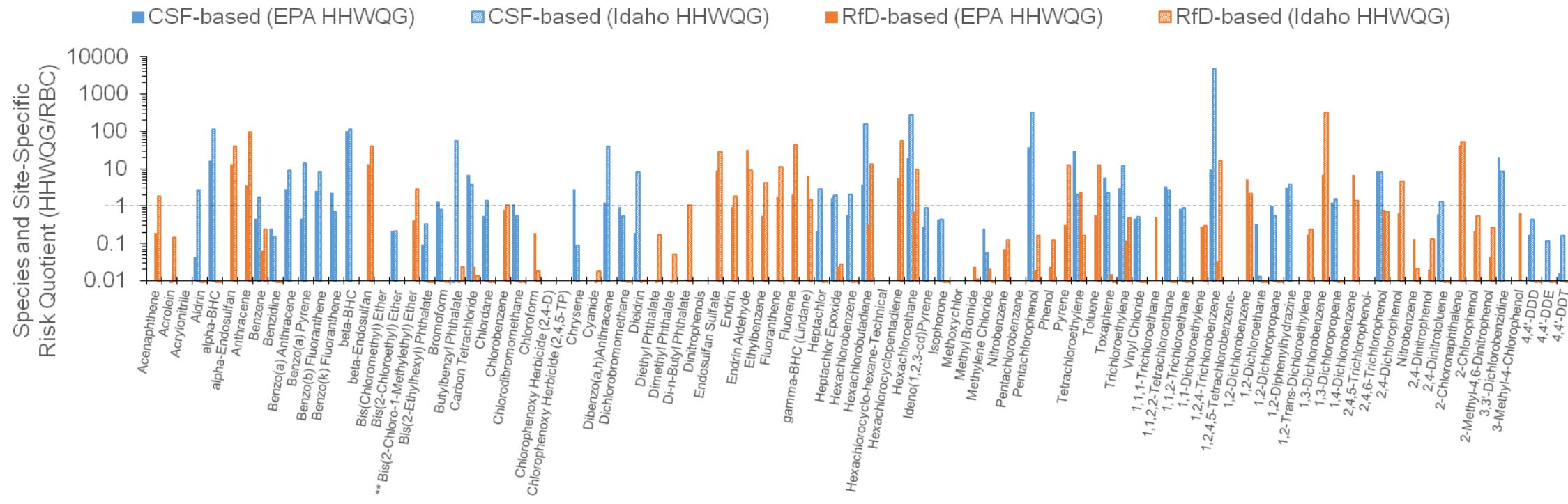


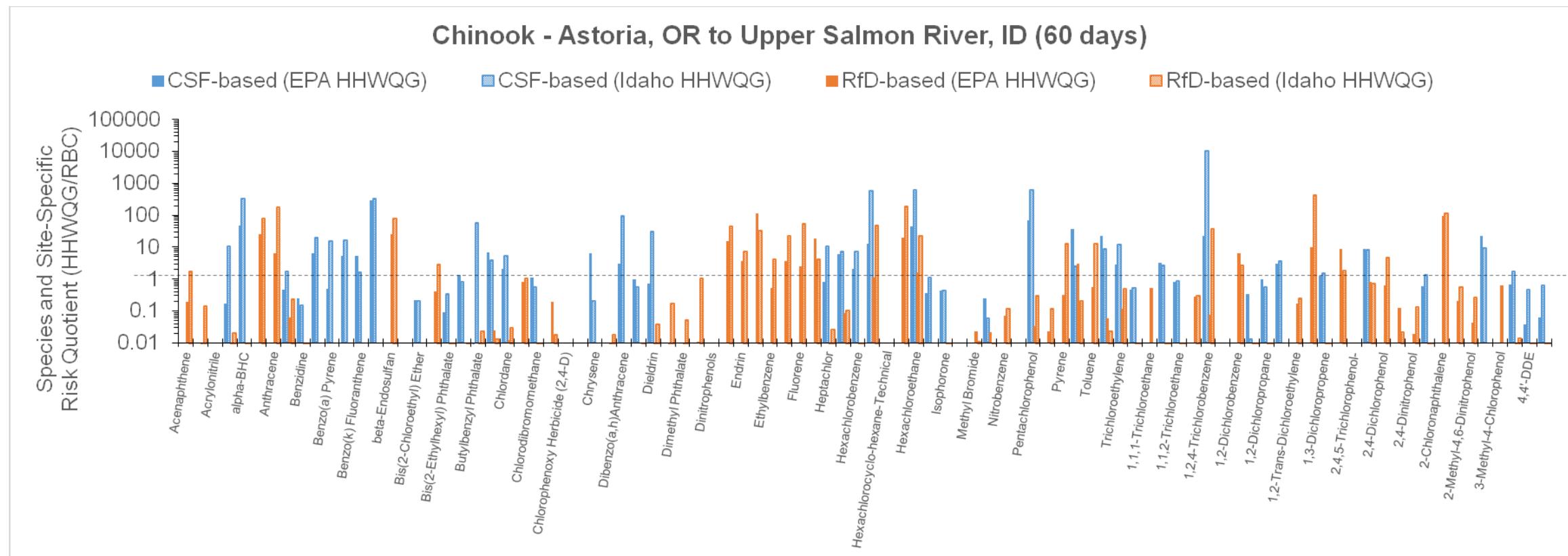
Chinook - Bonneville Dam to Lower Granite Dam (16 days)



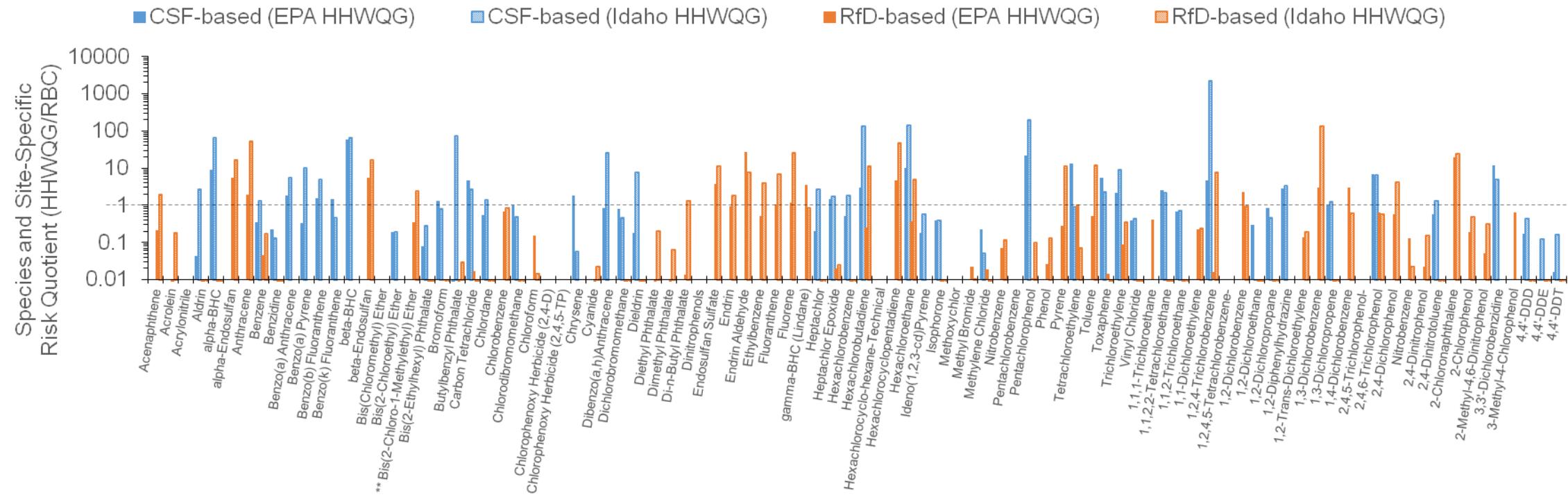


Chinook - Astoria to Hells Canyon Dam (40 days)

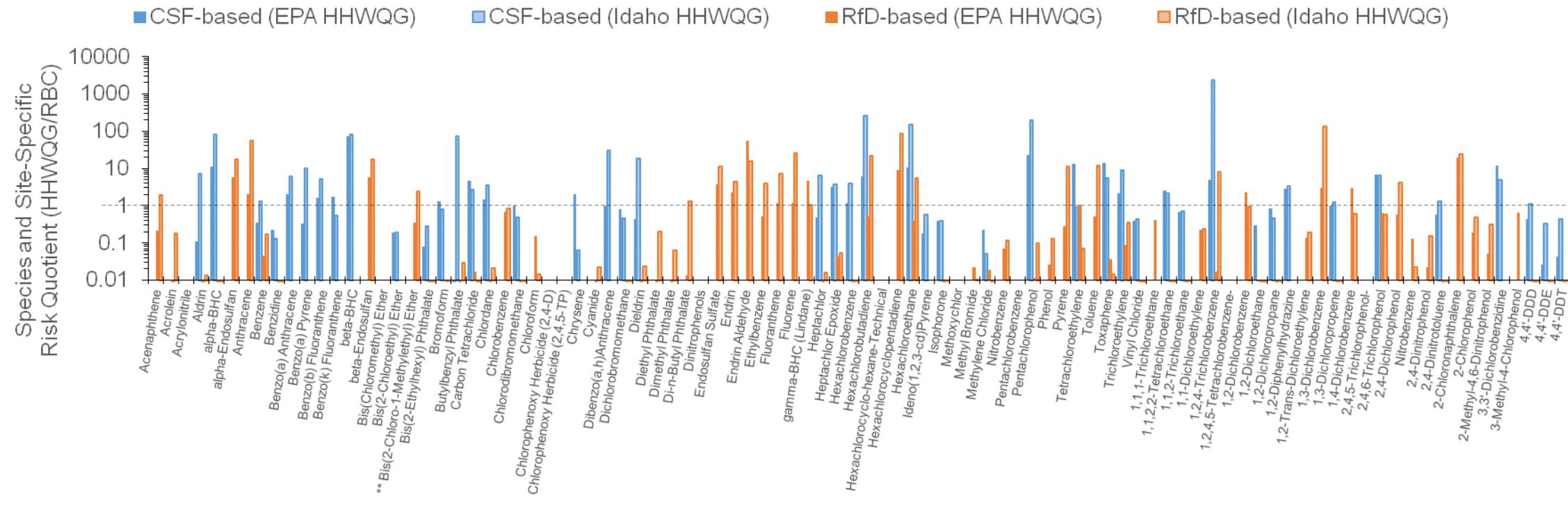




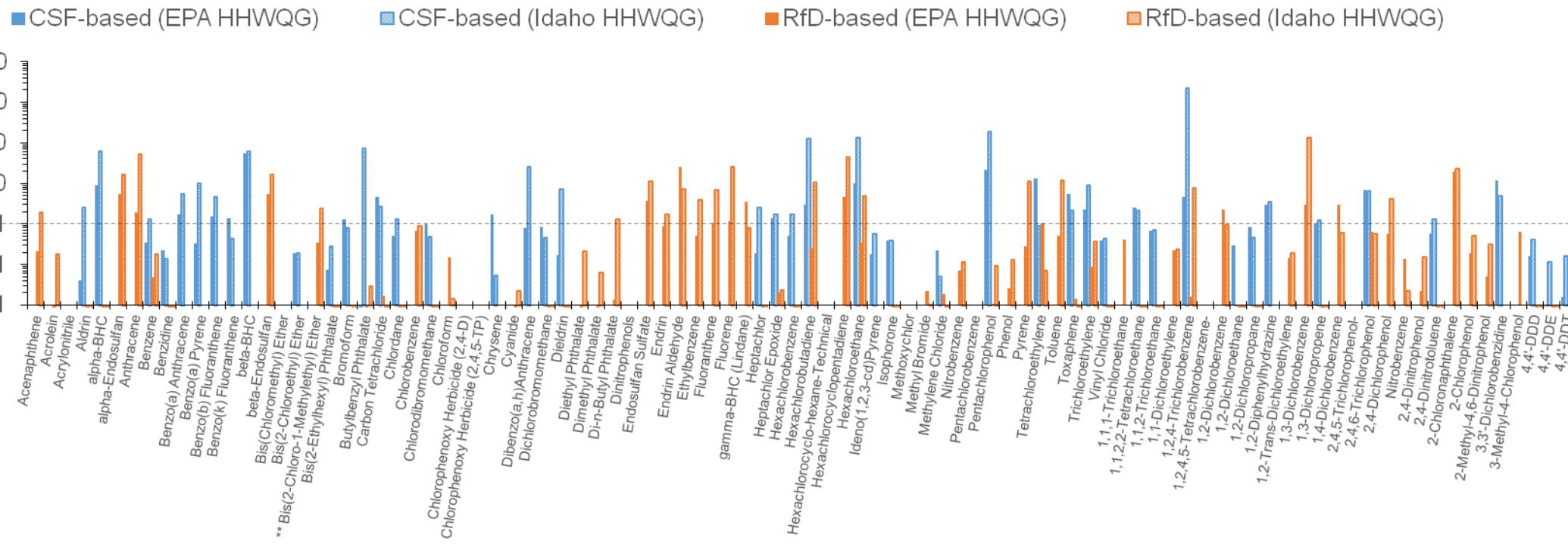
Sockeye Males - Astoria, OR to Wenatchee River (46 days)



Sockeye Males - Astoria, OR to Redfish Lake, ID (80 days)



Sockeye Females - Astoria, OR to Wenatchee River (46 days)



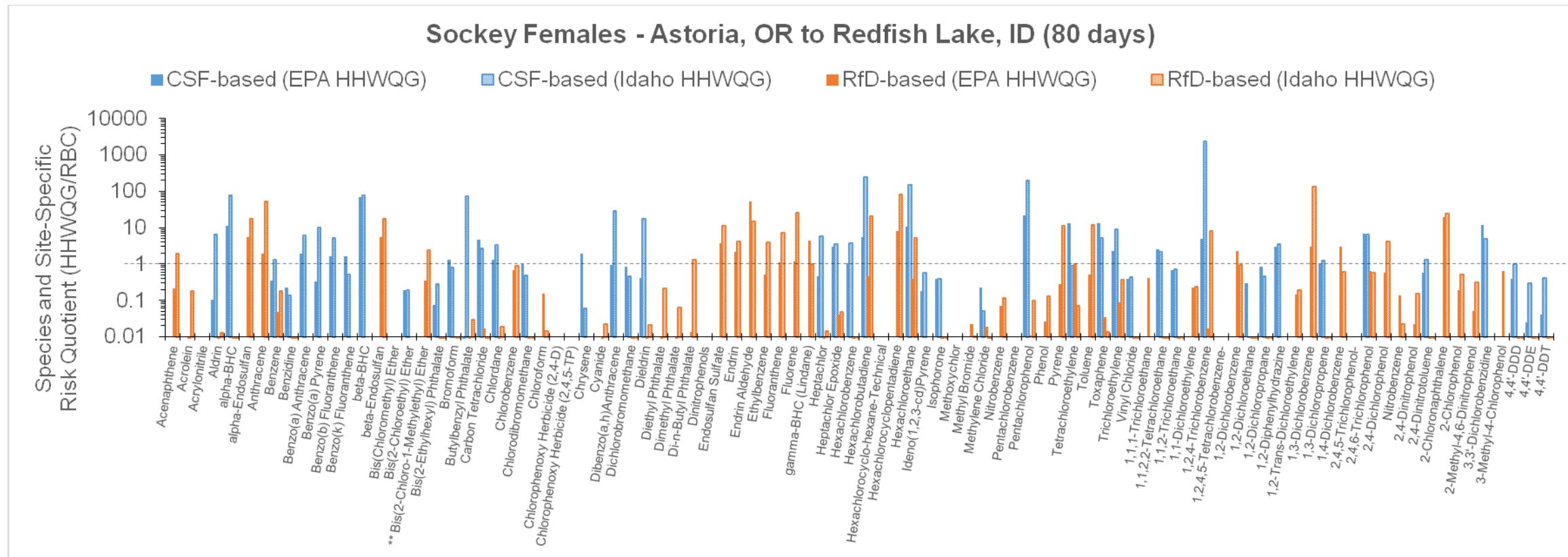


Figure A1: Risk Quotients (HH WQG / RBC) for chemicals of the present study for Chinook and Sockeye Salmon at different migration pathways. A Risk Quotient below suggests that the Guideline levels are protective for a risk level of 1E-6 (cancer based risk) or a Hazard Index of 1 (non cancer-based risk) based on dietary exposure to the migrating salmon.